McGraw-Hill Publishing Company, Inc.
James H. McGraw, *Chairman of the Board*
Malcolm Muir, *President*
H. C. Parmelee, *Editorial Director*

POWER

FRED R. LOW, *Editor*

Irving Fellner
Publishing Director

Volume 69 New York, February 12, 1929 *Number 7*

Productivity and Prosperity

MUCH is said about the increased production per man and its effect upon prosperity.

It is evident that the more things there are produced the more there will be for people to enjoy.

And if the worker gets a fair share of his product, he will have a part in the enjoyment of the increase of good things and prosperity will be general.

This means generous wages in order to supply large purchasing power to absorb the increased output.

But high wages do not necessarily mean large purchasing power.

If wages and salaries were doubled, the cost of the commodities and services produced and rendered by the workers would double, for practically every item of cost is reducible to human labor.

Unless the amount of human labor put into an article or a service is reduced, the purchasing power of a day's work will not be increased.

Or, to put it another way, unless the workman produces more for the same money, he will get no more for his day's work.

I mean labor collectively, the typical worker with hands or head, not certain trades, classes and individuals who have maneuvered themselves into positions in which they get disproportionate shares of the product.

Viewed in this way, it is apparent that sabotage, the willful limiting of one's output, "the conscientious withholding of efficiency," reacts upon those who practice it, while economy of time and material and industrious application make one's product cheaper to himself as well as to others.

And if everybody does it and the increase is not appropriated as profit, everything will be less expensive to everybody, purchasing power will be high, business good and opportunities for employment plenty.

Another way to increase the output per worker is to give him improved machines and processes; to replace man power by mechanical power.

But the productivity per worker is a composite quantity.

Will the man-hours per unit of output be reduced by putting in a machine and including all the man-hours required to make and maintain it per unit that it will have eventually turned out when it is discarded?

They usually will, abundantly; and the furnishing by American industry to each of its operatives of several times as much power as is provided by other countries is undoubtedly a big factor in present prosperity.

F. R. Low

POWER *Stands for . . .*

1. **Making Power When It Should Be Made**
2. **Buying Power When It Should Be Bought**
3. **Cheaper Power Through Modern Equipment**
4. **Easier Financing of Equipment Purchases**
5. **Better Use of Byproduct Heat and Power**
6. **Operating Methods That Save Money**
7. **Less Waste in Transmission and Application**

Give Energy Flow a Cleared Channel

DID you ever notice the resemblance between the energy-flow diagram for an industrial plant and a river? Allowing for the essential fact that the flow is in opposite directions in the two cases, the parallel is close.

The source of the energy flow is the power house. Here the flow of energy is at a maximum. All the various power services—steam, electricity, water pressure, air pressure, refrigeration—form the wide power stream flowing to the factory. As this stream comes to the points of application, branches split off. If the overall efficiency of utilization were perfect, all the energy flowing in the main stream would go to these points of application and be used up.

However, just as rocks in the river bed obstruct the flow and dissipate the energy of the river, so do obstructions to the energy flow split off part of the stream and waste it.

Looked at in this way, the problem of waste elimination in the use of power services becomes easier to comprehend, though not to solve. Plot such a flow diagram. Place on it each point of useful application and the amount consumed there. Trace the losses and spot them on the diagram. When all this is done, the obstructions to full utilization become evident. Dynamite them from the channel!

Combining Purchased and Privately Generated Power

COINCIDENT with progress along technical lines has come a more common-sense view of power supply. Seldom does one see evidence of the animosity so prevalent a few years back between central-station men and those identified with isolated plants. Even the power salesman is now willing to concede the private plant a place in some process industries, and the operating engineer can see purchased power in many cases where there is neither a heating nor a process steam demand. Obviously, a certain amount of commercial rivalry still obtains, but this often serves as a desirable check against hasty and incomplete decision.

That a manufacturing plant has use for considerable quantities of process steam, as well as power, does not always imply that to generate all the power will be cheaper. The extent to which coincidence exists between steam and power demands usually affects the decision, and in many cases points to a combination of purchased and generated power as the more economical. Increasing numbers of industrial plants are following this practice, and it is being welcomed by the more progressive central stations.

A case in point is the new Campbell Soup company plant at Chicago which is described in this issue. Processes demanded steam at twenty-five pounds and at one hundred pounds, the quantity of the former dictating the employment of a one-thousand kilowatt non-condensing turbine. This will be operated up to the demand for twenty-five pound steam, and purchased power will carry the remainder of the electrical load as well as provide a stand-by.

Offhand, one might presume that here was an ideal case for generating all the power owing to the large steam demands for cooking, but a careful study of probable operating conditions based on experience with the Camden plant of the same company indicated a combination of generated and purchased power as proper.

Power of the Future

WHEN the imaginative artist paints a picture of the metropolis of the future, he makes the skyscrapers higher, double-decks the streets, fills the sky with airplanes and dirigibles differing little from existing designs and adds a few landing fields on the tops of buildings. Nothing really new—merely the enlargement and multiplication of what already exists in commercial or semi-commercial form.

The artist does the same with the future power plant. He doubles or triples its height, runs the stack up into the sky and increases the boilers, turbines and generators to gigantic proportions. Again, nothing new! Merely more of the same thing—bigger, and presumably better! Thus these imaginative efforts are seen to follow the line of least resistance and to involve little that is truly creative in an engineering sense.

Such imaginings are not to be laughed off, because they are entirely within the realm of possibility. Yet there are so many other possibilities that it would indeed be rash to predict future progress as a mere expansion of present practice.

While steam is still the most likely fluid for power generation, it is not at all certain that the power plant of fifty years hence will depend on the evaporation of water and the expansion of steam in turbines. Fluids may be found, or produced synthetically, that will be more friendly to the efficiency possibilities of Carnot's law. And the vapor may be expanded in apparatus differing as fundamentally from the modern turbine as

it differs, in turn, from the reciprocating engine. Failure of the "1929" imagination to conceive of such an engine no more disproves its possibility than did the failure of "1850" engineers to imagine the steam turbine render it impossible.

In the same way, the internal-combustion engine may evolve into machines undreamed of today. It is even within the bounds of possibility—at least, while "possibility" must include the great field of our present ignorance of the nature of matter and energy—that a more direct transfer of fuel energy into electricity may be achieved on a commercial scale.

These are interesting speculations that deserve the thought and efforts of a few scientific minds adequately equipped and supported for such work. Meanwhile, the rank and file of engineers must work for the gradual step-by-step improvement of existing apparatus and the lifting of the general level of operation to the best now obtainable.

The Plant Operator Must Decide

STANDARDS for high-potential testing of electrical-machinery insulation have been established by the American Institute of Electrical Engineers. These tests are primarily a basis on which to compare equipment of different manufacturers. While these, when applied in conjunction with others, are a satisfactory means of judging insulation quality of a new machine, they do not provide a suitable standard after the machine has gone into operation. Those who formulated the standards apparently had in mind the objections to applying them to used machines, for it is stated, "High-voltage tests to determine whether specifications are fulfilled are admissible on new machines only."

There are several reasons for not applying the high-potential tests, recommended by the present standards, to used machines. A voltage test applied to insulation may not cause a failure, but may produce a condition that will eventually develop into a breakdown. For this reason some operators object to applying high-voltage tests to machine windings after they have been in service. These operators point to longer service of machines, the insulation of which would have failed if a standard high-voltage test had been applied.

After a machine has been in service for a period, even when thoroughly cleaned and dried out, the insulation may not regain its original qualities. This being the case, there seems to be no reason why these machines should be subjected to the full standard test voltage.

Resistance tests show the condition of the insulation, but do not indicate how well it will stand high voltage. The only way that this may be determined is to apply a voltage in excess of normal working value. Many operators feel that this should be done. How high the voltage should be is open to controversy. Some choose eighty-five per cent of the standard. Others give preference to seventy-five per cent. The question of how long the voltage should be applied also enters in.

At the recent convention of the A.I.E.E. a paper was presented on "Insulation Tests of Electrical Machinery Before and After Going into Service." This paper was prepared by an engineer with a large operating company and one with a large electrical manufacturing company. Both the operating and manufacturing points of view were presented in a highly commendable manner. The disappointing part was the absence of discussion by operating engineers, the major portion of the discussion being carried on by the manufacturer's representatives.

Although the manufacturers can give valuable assistance in formulating such a standard, theirs is a secondary interest. This question is primarily an operating one; if there is to be a standard test voltage for used machines, it is something for the operators to decide.

Creeping Up on Nature

THE one hope of engineering lies in the fact that nature, relatively speaking, stands still. Laws that worked yesterday, work today and tomorrow. If they don't, it is the interpreter, not the lawmaker, who is to blame. Thus engineers and research men are steadily creeping up on nature.

A notable example of this creeping up process is to be found in the high-voltage laboratory, where electrical engineers have long been attempting to reproduce lightning under perfect control. Splendid engineering and original thought have made great progress in the last year in this field. From 3,600,000 volts twelve months ago, impulses of 5,000,000 volts have lately been achieved; and F. W. Peek, Jr., who is responsible for the research and believes that the present figure is no limit, is working toward ten million. Already he has reproduced five per cent of the voltage of the natural lightning flash, which gives him a direct means of studying power-line phenomena under actual thunderstorm conditions.

Previous researches have given us lightning arresters, insulators and transformers able to withstand nature's worst onslaughts. Peek says himself that the practically lightning-proof line is in sight, which is an achievement of the utmost importance in sending reliable central-station power to all parts of the country.

Nature, one must admit, is a kind antagonist when one of her strongest weapons of aggression is first dulled and then rendered harmless without her saying a word!

Science in the Spotlight

ONE hundred years ago most men knew nothing about science, nor did they care to learn. During the intervening years, however, all this has changed. Progressively supplied with such devices as the railway, steamboat, telegraph, telephone, electric light, automobile, airplane and radio, man has come to realize how he depends upon science to maintain his living standards. Popular interest in scientific discoveries is at high tide. Einstein makes the first page!

Combination of Generated Effects Heat Balance

Preliminary surveys for daily outputs established definite demands for the services at the new Campbell Soup Company plant in Chicago, with the result that power is generated by a turbine unit exhausting at 25 lb. to process. A public-service connection furnishes additional power and provides a stand-by.

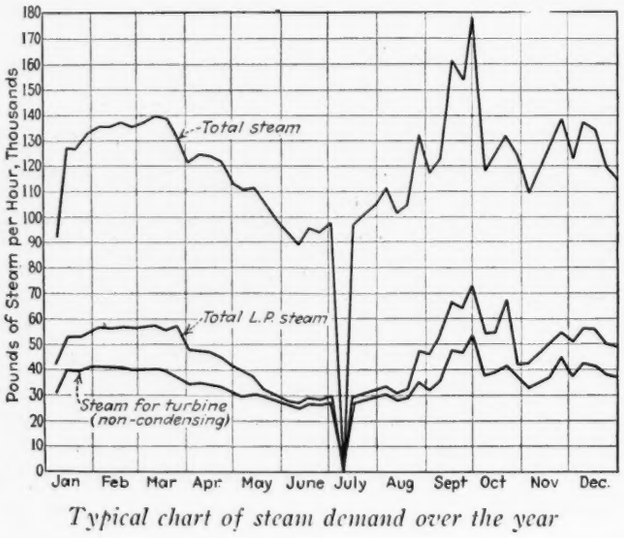
CAMPBELL Soup Company has completed recently a new plant at Thirty-fifth and Rockwell Streets, Chicago, a location selected for its switching facilities, its close proximity to the source of meat products used and its access to labor supply. The first unit, completed at this time, consists of a six-story manufacturing building having 400,000 sq.ft. of floor space, a three-story warehouse with 300,000 sq.ft. of floor space, and a power plant. The layout of the plant has been arranged to allow for a 50 per cent expansion of manufacturing area and 25 per cent increase in warehouse space. Provision is also made for the future erection of two units for the preparation of tomato soup.

On the same site the Continental Can Company has erected a plant for supplying cans that will travel as required on cable conveyors direct to the Campbell inspection tables and filling machines.

Such a food products establishment requires a maximum of the various services, so a power plant was built at the rear of the site, as centrally located as possible and with provision for expansion. Preliminary to laying out the plant, a survey was made of the service requirements of the Camden, N. J., plant of the company, where accurate records had been kept for many years. Charts were plotted showing daily production for several years, and charts for the same year, showing daily and hourly demands for steam, water, electricity, etc.

From these data curves were drawn indicating pounds of steam, kilowatts, gallons of water, etc., required per hour per unit of production for various daily outputs. It was thus easy to determine the demand for any service at any hour or season for any predetermined output of finished goods. Allowances were made for differences between Camden and Chicago in the heating season, in the lighting load, owing to building construction, in refrigerating demand, owing to smaller requirements because of the closer proximity to the fresh meat supply, and in other variables.

For the first unit of the plant, including the first tomato products unit, it was found that the maximum demands would be as given in the first column of the accompanying table. The second column shows these for the complete plant.



Typical chart of steam demand over the year

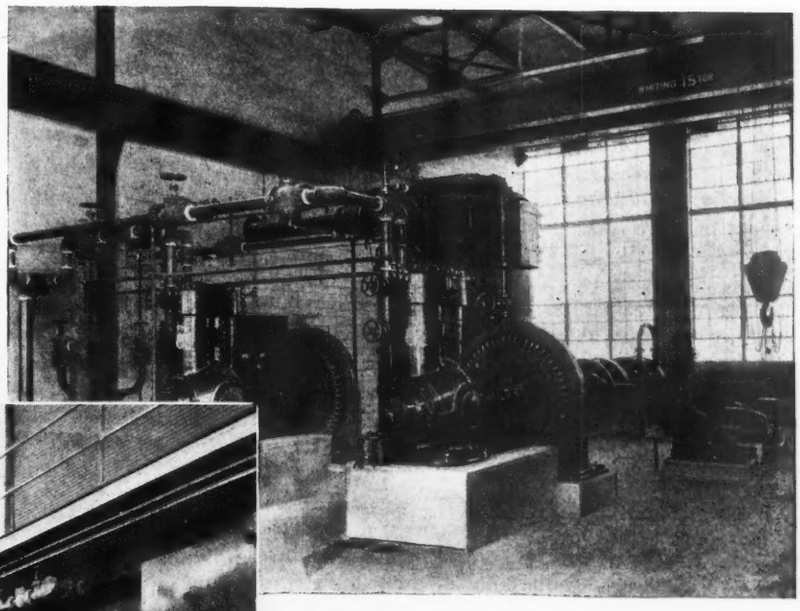
In the power house only such equipment was installed as was necessary for the first unit of the plant and the first tomato products unit, except where it was more economical in first cost or floor space to provide for the future. Throughout the design the first thought was simplicity and assurance against shutdown, extremely high efficiency in certain cases being sacrificed to attain this result.

Coal is supplied by rail from Illinois fields, hence forced-draft chain grates were selected. With this type of stoker the highest efficiency can be obtained when operating the boilers at 150 to 200 per cent rating. The summer load figures about 100,000 lb. of steam an hour and the winter load about 130,000 lb. an hour. The maximum demand, after the first tomato products unit is in operation, will last but a few weeks at 180,000 lb. or less. Under these conditions four 6,000-sq.ft. boilers were installed. Three, operating at 200 per cent rating, will carry the maximum load except for about four weeks during the tomato season, when all four boilers will be on the line for eight hours a day and operating at 225 per cent rating. The boilers and stokers are capable of developing 300 per cent rating, so that even under maximum conditions three units would be able to supply the demand at somewhat reduced efficiency.

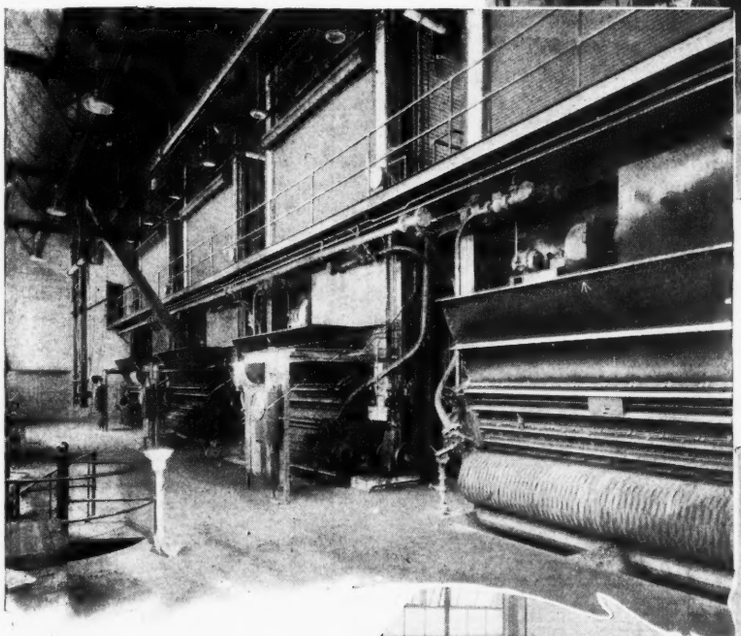
For process the highest steam pressure required is 100 lb. but as electric power is generated, a pressure of 225 lb. is carried on the boilers. No superheaters are installed, but steam purifiers are placed in each boiler

and Purchased Power . . . in Food Products Plant

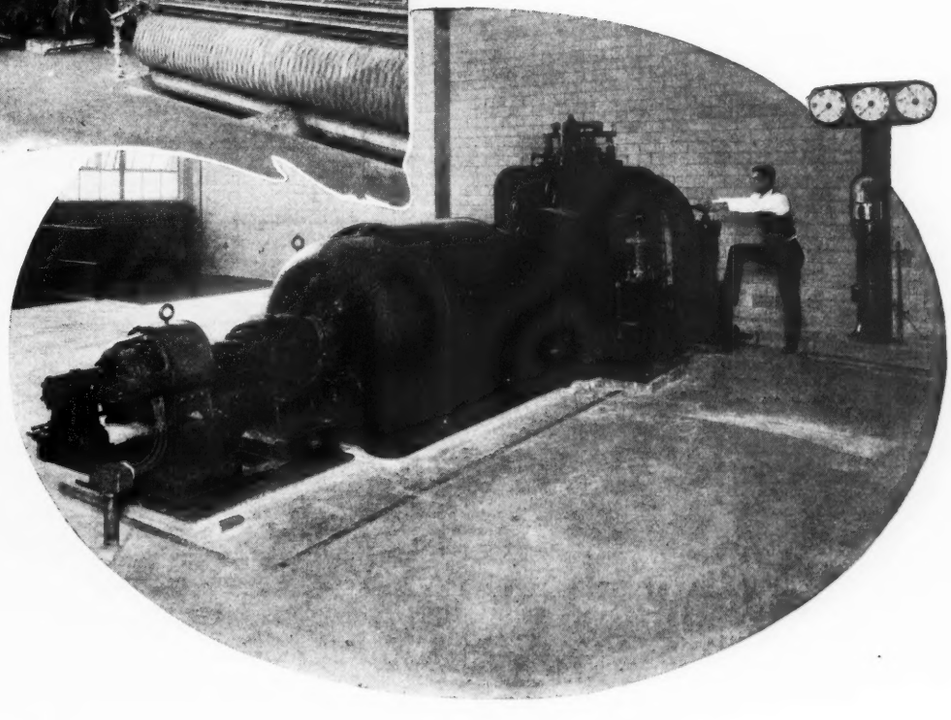
By C. A. Scribner
Engineer, Battey & Kipp, Chicago



Two 50-ton ammonia compressors with open feed-water heater, air compressors and motor-generator sets in background



The four boiler units are served by forced-draft chain grates



The noncondensing single-stage turbine unit exhausts to process at 25 pounds

to insure practically dry steam. The boilers are of the box-header type, set singly. The settings are of the Alert type with a horizontal baffle above the third row of tubes extending from the front of the setting to the first vertical baffle. In the bottom row every other tube is omitted to form a slag screen. Soot blowers are provided.

The stokers are of the link type, 12 ft. wide by 12 ft. long, with 144 sq.ft. of active grate area. Pressure water backs and square side-wall pressure water boxes are provided with the necessary circulating tubes and blowoff connections. Each stoker is driven by a vertical steam engine having an inclosed governor.

Suspension-type combustion and ignition arches are provided and suspended-type air-cooled side and rear walls inclose the furnace. Between the air passages in the walls and the steel casing insulating brick is used.

Motor-driven forced-draft fans, one per boiler, are directly behind the rear walls of the furnaces and below the rear boiler headers. Connections are taken from the air duct below the boiler-room floor to supply air under pressure to the air-cooled wall passages at the rear. This air passes completely around each side wall and is collected in a large plenum box in front. From here it is drawn by a small fan placed under the arch and behind and above the stoker extension hoppers. This fan delivers the warm air from the walls to nozzles placed at intervals through the ignition arch to discharge over the fire. It combines the use of overfire air, which has been proved a great help to efficient and smokeless combustion, with the advantage of air-cooled walls and the use of the hot air often wasted in stoker-fired air-cooled-wall installations. Air preheaters were considered, but despite the increased efficiency obtainable, their installation was omitted to conserve building space and reduce plant maintenance.

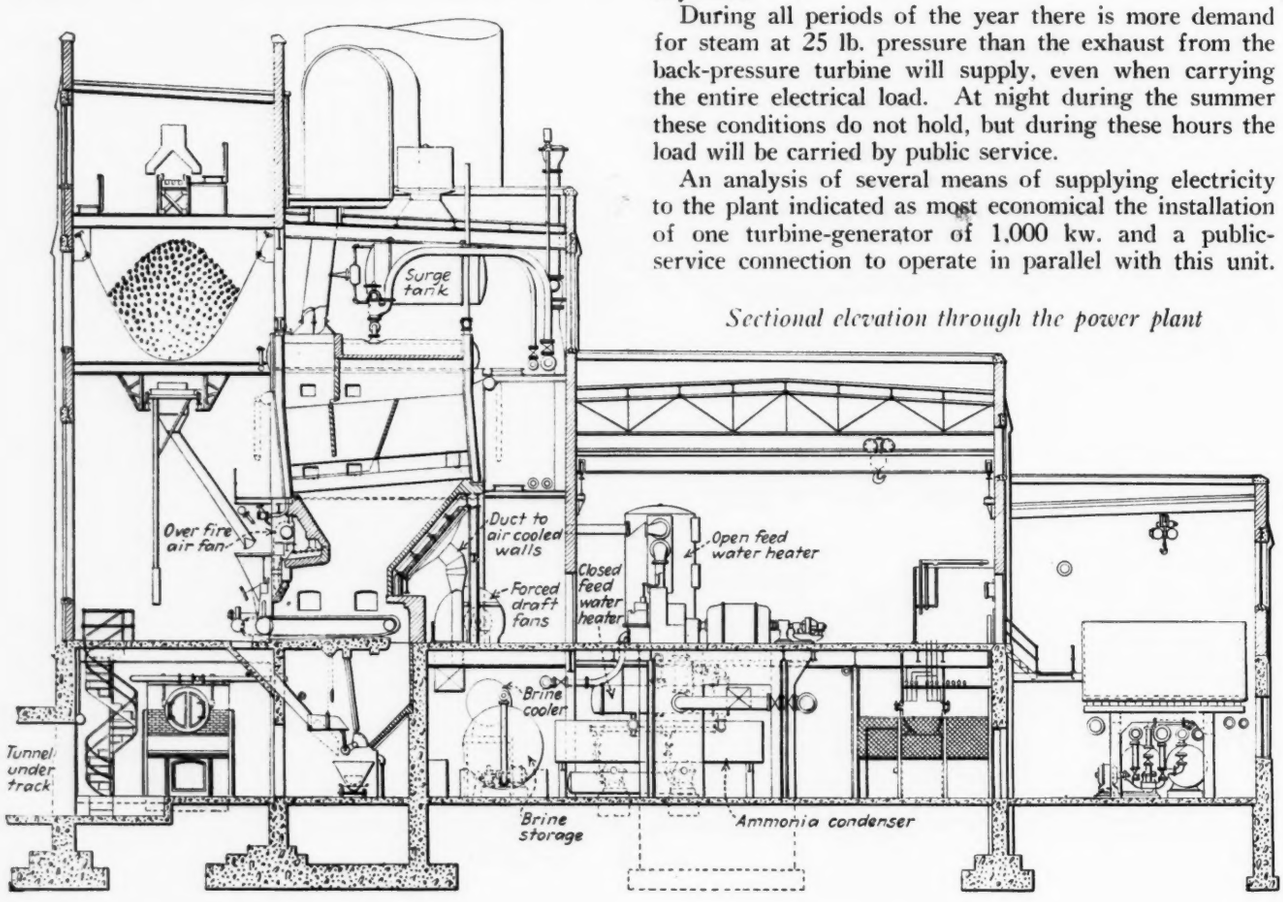
Run-of-mine coal is delivered in bottom-dump cars on the elevated track and dropped to a rectangular vertical-sided bin, open on one side. The coal fills this bin and after the pile is built up to about five feet, slides into a hopper adjacent to a conveyor tower (see photograph). The bottom of this hopper is fitted with a sliding gate for emergency use. Ordinarily, the gate is kept open and the coal falls on an apron feeder which delivers it to a crusher. From the crusher a pivoted-bucket conveyor carries the coal to the top of the tower and delivers it to a belt conveyor with traveling tripper, which in turn delivers to an overhead suspended steel coal bunker extending the length of the firing aisle. The bunker is fitted with twelve larry-operated coal valves, and underneath is a motor-operated larry spouting to extension hoppers over the stokers. For the storage and reclamation of coal drag-scraper equipment is installed. Three months' supply of coal may be stored in the area provided for this purpose.

Ashes are dropped directly into watertight hoppers lined with brick and equipped with quenchers. Through inclined overcut gates they are removed from the hoppers to a hand-propelled ash car which empties into a delivery chute which, in turn, discharges into the pivoted-bucket conveyor that is used for the coal. The ashes are carried up to a bunker near the top of the tower, from which delivery is made into coal cars.

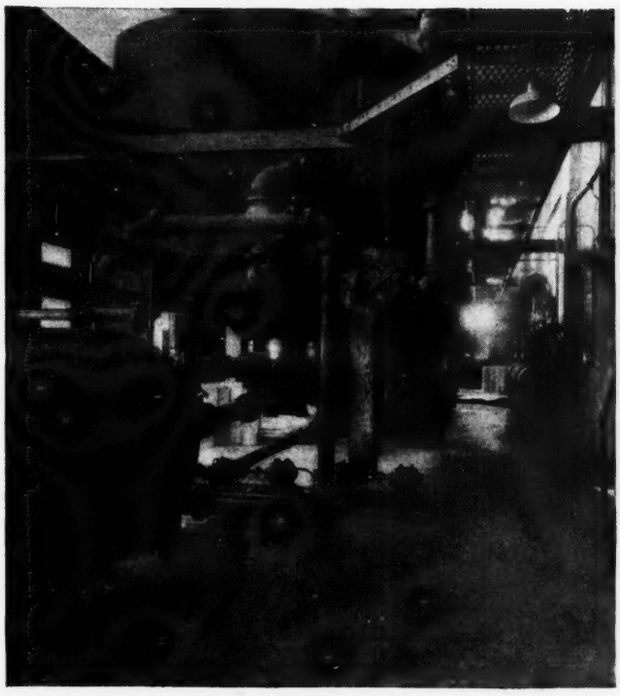
The coal and ash equipments are electrically interlocked so that the crusher and coal feeder cannot be used while ashes are being handled. Also, the belt conveyor, bucket conveyor, crusher and feeder must start in the sequence named to avoid any possibility of coal piling up on any unit.

During all periods of the year there is more demand for steam at 25 lb. pressure than the exhaust from the back-pressure turbine will supply, even when carrying the entire electrical load. At night during the summer these conditions do not hold, but during these hours the load will be carried by public service.

An analysis of several means of supplying electricity to the plant indicated as most economical the installation of one turbine-generator of 1,000 kw. and a public-service connection to operate in parallel with this unit.



Sectional elevation through the power plant



Filter room containing three gravity filters, pumps and storage-type service water heaters

Forced-draft fans and connections from main air duct under floor to air-cooled boiler walls

PRINCIPAL EQUIPMENT IN NEW POWER PLANT OF CAMPBELL SOUP COMPANY, CHICAGO

Boilers, four 6,072 sq.ft. Edge Moor.
Steam pressure, lb. gage, 225.
Boiler Setting, Alert type; bottom front header 14 ft. above floor; Detrick air-cooled arches and side rear walls; Maroney firebrick above furnace; "Flame Brand" high-temperature cement; steel casing lined with Sil-O-Cel brick; Vastine observation doors; Diamond "Valv-in-Head," 6-element soot blowers.
Boiler Fittings and Accessories, Consolidated safety valves; Everlasting tandem blowoff valves; Golden-Anderson triple-duty non-return valves; Ashcroft steam gages; Reliance water columns; Hagen steam purifiers, 3 per boiler.
Refuse burning boiler, one Union Iron Works 2-drum universal fire tube, 1,000 sq.ft., shaking grates, 25 lb. pressure.
Stokers, 4 Green (Combustion Engineering Corp.) forced-draft chain grates, 144 sq.ft., pressure water backs and side-wall water boxes.
Stoker engines, 4 Troy, 4x4-in., with Pickering governors.
Fans, forced-draft, four 25,000-c.f.m., Sturtevant turbo-vane, driven by 25-hp. General Electric induction motors.
Fans, overfire air, four 3,500-c.f.m., Sturtevant multivane, driven by 5-hp. General Electric induction motors.
Chimney, one 250x12 ft. Alphons Custodis radial brick.
Breeching and forced-draft ducts, Connery & Co.
Combustion control system, Brooke Engineering Corp.
Feed-water heater, open, one 150,000-lb. per hour Milwaukee Reliance Boiler Works.
Feed-water heater, closed, one four-pass Griscom-Russell horizontal, 1,110 sq.ft.
Heaters, service water, 2 U-tube, Griscom-Russell, storage type, 130 g.p.m. from 60 to 200 deg. F.
Filters, 3 gravity type, 600 g.p.m. International.
Boiler-feed pumps, 2 American centrifugal, 400 g.p.m. against 300 lb. head, driven by 150-hp. G. E. single-stage turbines.
General service pumps, 4 American centrifugal, 1,000 g.p.m., against 170 ft. head, driven by 75-hp. G. E. syn. motors.
Hotwell pumps for h.p. drips, 2 American centrifugal, 200 g.p.m., against 50-ft. head, driven by 5-hp. G. E. ind. motors.
Hot-water circulating pumps, 2 American centrifugal, 30 g.p.m. against 40-ft. head, driven by 2-hp. G. E. motors.
Fire pump, 1 Dayton Dowd, centrifugal, 1,500 g.p.m., driven by a 15-hp. Standard turbine.
Brine-circulating pump, American centrifugal, 300 g.p.m. against 60-ft. head, driven by a 15-hp. General Electric motor.

Refrigerating Equipment

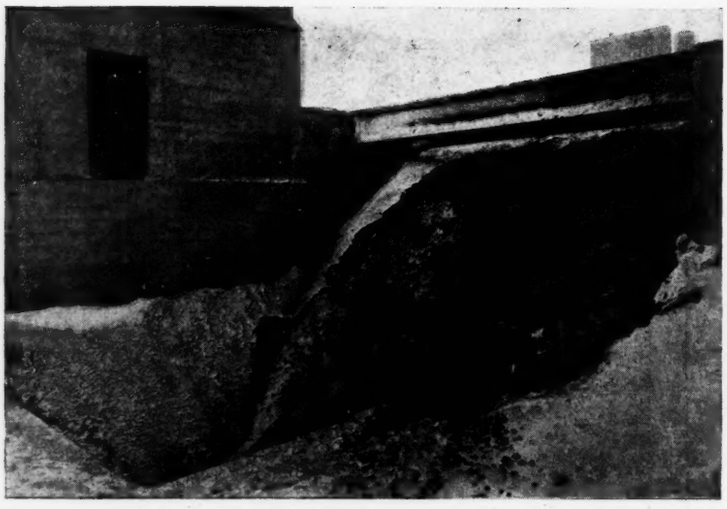
Ammonia compressors, two Baker 50-ton single-acting, double-cylinder, driven by G. E. 100-hp. syn. motors.
Brine coolers, 2 Vogt hor. shell-and-tube type.
Brine storage tank, one 8x16 ft.; one brine mixing tank, 200 gal.; one double-pipe condenser; two ammonia receivers, Burge Ice Machine Co.
Air compressors, two single-stage Sullivan, 200 cu.ft. per min., 125 lb., belt driven by G. E. 50-hp. syn. motors.
Coal and ash handling, apron feeder, swing hammer crusher, bucket conveyor, belt conveyor and tripper, 60 tons per hour capacity; ash feeder and 27-cu.ft. ash car; one-ton electric weigh larry, Jeffrey Mfg. Co.
Ash hoppers, Beaumont, brick lined, with gates under stokers; 70-ton per hour drag scraper equipment.
Turbine-generator, one 1,000-kw. Westinghouse noncondensing, 225 lb. initial and 25 lb. back pressure; direct-connected exciter.
Generator air cooler, Griscom-Russell fin type.
Oil filter, S. F. Bowser & Co.

Electrical Equipment

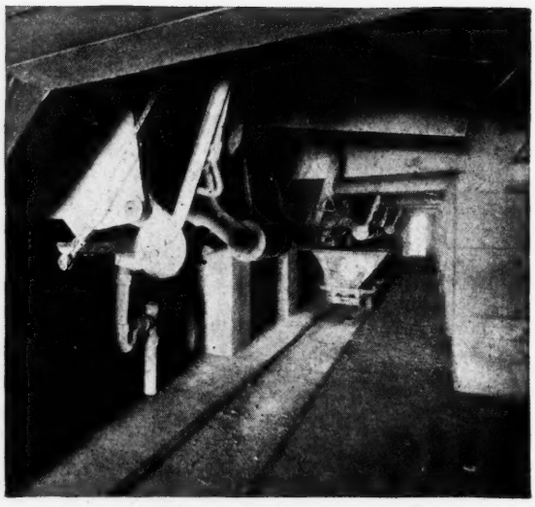
Switchboard.....Chicago Switchboard Mfg. Co.
Indicating meters.....Weston Elec. Inst. Corp.
Graphic instruments.....Esterline-Angus Co.
Circuit-breakers.....I. T. E. Circuit Breaker Co.
Transformers, 3 single-phase, 300 kva., 440 to 220-110 v., Pittsburgh Transformer Co.
Motor generators, two 16-kw.....General Electric

Miscellaneous Equipment

Crane, one, 15-ton hand.....Whiting Corp.
Grating, "Subway".....Irving Iron Works Co.
Piping wrought iron.....Reading Iron Co.
Pipe covering, 85 per cent magnesia, Johns-Manville Corp.
Fabricated pipe.....Midwest Piping & Supply Co.
Valves, gate.....Chapman Valve Mfg. Co.
Valves, globe.....Walworth Co.
Valves, back pressure.....Cochrane Corp.
Valve, non-return on turbine, wing type, G. M. Davis Reg. Co.
Valves, reducing.....Leslie Co.
Traps, steam.....Illinois Engineering Co.



The coal pocket is supplied from railway cars or from storage by means of a drag scraper



Ash hoppers, equipped with inclined overcut gates, and industrial ash car

The plan is to operate the turbine to capacity or up to the demand for 25-lb. steam and allow the public service to carry the remainder of the load as well as to provide a stand-by. Steam and electricity are also to be supplied to the can company.

The turbine is a single-stage noncondensing machine directly coupled to a three-phase 60-cycle 480-volt generator with the exciter mounted on the same shaft. It is equipped with an electrically operated speed changer. Other appurtenances are a generator air cooler and an oil filtering system.

Requirements for 25-lb. steam in addition to that supplied from the turbine exhaust and a refuse burning boiler, are made up from the 225-lb. live-steam main through reducing valves. From the same source process

MAXIMUM DEMANDS FOR THE VARIOUS SERVICES

	First Unit	Complete Plant
High-pressure steam, lb. per hour	107,000	140,000
Low-pressure steam, lb. per hour	73,000	110,000
Total steam, lb. per hour	180,000	250,000
Electric current, kw.	1,400	2,100
Cold unfiltered water, gal. per min.	2,000	3,000
Cold filtered water, gal. per min.	750	1,500
Hot filtered water, gal. per min.	200	300
Compressed air, cu.ft. per min.	200	200
Refrigeration, tons per day	40	50

steam at 100 lb. pressure is supplied the factory. Uses for the 25-lb. steam are building and water heating, sterilizing, cooking, and in the power house feed-water heating in a closed heater installed between the boiler feed pumps and the feed header.

In the main buildings, condensate from the heating system is delivered to vacuum pumps and returned through a tunnel to a surge tank hung from roof girders above the boilers. All returns from equipment requiring high- or low-pressure steam flow back through the tunnel by gravity to a vented hotwell tank hung from the roof of the tunnel entrance at the power house. In a pit below this tank are installed two pumps which elevate these returns to the surge tank. Under float control fresh filtered makeup water, which is metered, also enters the surge tank. All the feed water from this surge tank flows to an open heater supplied with exhaust steam from the stoker engines and turbine-driven feed pumps, and from here is forced through the closed heater to the boilers. A regulator at each boiler controls the feed and a Venturi meter measures all water from the closed heater.

At the same level as the boiler room and separated from it by a semi-glazed tile wall, is the turbine room. In it are the turbine-generator, two 50-ton motor-driven ammonia compressors, two 200-cu.ft. motor-driven air compressors, the open feed-water heater, two 15-kw. motor-generator sets, the main switchboard and the chief engineer's office. Space is provided for the installation of two additional turbine-generators. A 15-ton hand-operated crane serves this floor, and also, through a hatch, the floor below.

The ground floor below the turbine room extends under the rear boiler columns to the bridge wall. A concrete dividing wall separates this area from the ash tunnel, thus providing an additional 14 ft. of width which otherwise could not be used to advantage. Housed in this space are the public service company's substation; the two turbine-driven boiler-feed pumps, with space for two more; the compressed-air receiver; the ammonia condensers, brine coolers, brine pumps and storage tank; the fire pump, and the lighting transformers. The equipment in this space is so arranged as to be directly below contiguous equipment on the floor above. All piping to the factory passes through this room and enters the pipe tunnel below ground.

Extensive Filtering Equipment Used

In the east portion of the building is the filter room containing three 15-ft. diameter gravity filters supported on concrete pads ten feet above the floor. Below the filters are four 1,000-g.p.m. motor-driven pumps so connected to the city water supply, that any one or more can deliver either filtered or unfiltered water to the factory through pipe lines in the tunnel. One 25,000-gal. unfiltered water tank and one of the same size for filtered water are placed on the eighth floor of the tower in the manufacturing building. These tanks float on the dead ends of the pipe lines from the pumps, the levels being kept constant by externally operated float valves. Service taps are taken from the mains to the tanks at various points. At one end of the filter room there are two storage-type service water heaters and small hot-water circulating pumps.

The 1,000-gal. pumps, the ammonia compressors and the air compressors are driven by synchronous motors, which receive their excitation from the previously-

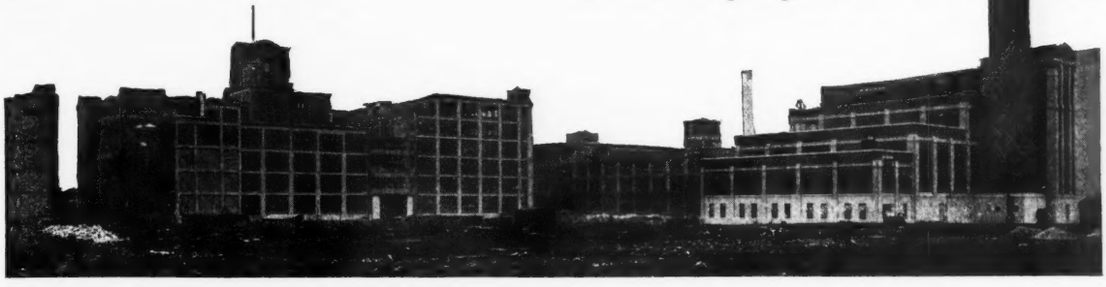
mentioned motor-generator sets installed in the turbine room.

Unfiltered water, used for cooling the compressors, ammonia condensers, transformers, the rear stoker shafts and the generator air cooler, is collected in a return header, emptied into any one of the filters, and after passing through the filter bed, is used as filtered water. This water is not contaminated in any way and the heat collected is not sufficient to be harmful. It might have been emptied into the surge tank, but at certain periods of the day there would have been sufficient surplus to overflow this tank, carrying along the hot condensate, which is undesirable. On the other hand, the load on the filters is such that the cooling water will seldom exceed the demand. By adopting the foregoing plan no spray pond or tower was required to prevent waste of cooling water.

On the switchboard, extending three-quarters of the length of the turbine room, public-service and generator panels tie into a common 440-volt bus which through transformers supplies the 220-110-volt lighting bus.

A gage board for steam water, brine and compressed air data is placed on the parti- tion wall between the turbine and boiler rooms. Here are mounted recording and in- dicating pressure gages and recording ther- mometers. A full complement of steam-flow meters, CO_2 recorders and other instruments is placed con- veniently throughout the plant.

The layout and design of the power plant, as well as the preliminary studies and final de- signs for the factory buildings and service sys- tems were carried out by Battey & Kipp, Inc., consulting engineers of Chi- cago.



Refiltering Lubricating Oil Reduces Costs

CLEANSING of lubricants by means of filtration or centrifugal purification is accepted as one of the outstanding factors in the maintenance of effective lubrication and in the reduction of lubrication costs.

Lubricating oils can be reconditioned or cleansed by one of three distinct methods: By precipitation and filtration; by centrifugal separation; by mechanical coagulation of the impurities by means of suitable chemicals.

Precipitation alone is an extremely lengthy operation, although dependent of course upon the viscosity of the oil and the amount of foreign matter contained. Normally, too, much time would be necessary for proper clarification of an oil. The rate of precipitation can be expedited by heating the oil to a certain extent to reduce its body or by addition of certain substances that differ sufficiently in specific gravity, to increase the rate of settlement of the contained impurities. Over the period of precipitation the oil should be as quiet as possible, for agitation to any extent would obviously interfere with settlement of material heavier than the former, so it is claimed by lubrication.

Precipitation Rarely Used Alone

In consequence, precipitation is generally resorted to only for partial clarification for the removal of larger and relatively heavier particles of foreign matter. Final treatment is carried out by filtration or screening the oil through porous material with openings fine enough to retain the majority of the remaining impurities. Wire cloth of finely woven canvas may be used for this purpose. The extent to which ultimate purification will be attained will depend upon the length of time the oil is treated and the fineness, weave or density of the filter.

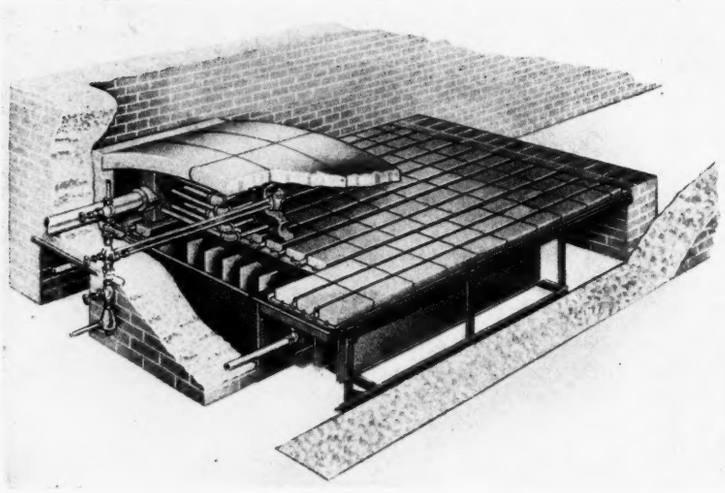
The modern industrial or power plant oil filter will in general provide for combined precipitation and filtration. The oil, as received from the lubricating system, is run to a strainer box to take out any larger, heavier particles of foreign matter, or to a heating tray, especially if it is a more viscous product, in order to promote subsequent precipitation and separation of as much water and sludge as possible.

After the oil has been freed of heavier foreign matter by precipitation, it is passed to the filter compartment. Filter bags or metallic frames covered with finely woven filter cloth are used for this purpose. Dirt and foreign matter accumulation on filter cloth will form an additional filtering media to a certain extent.

Centrifugal Separation

The principles of centrifugal force are also applied to oil purification. Separation of substances or fluids of different specific gravity can be effectively brought about by centrifugal force, in a comparatively short time, owing to the intensity of the force involved. As in the case of precipitation, moderate heating is an adjunct to effective separation by centrifugal force, due to the resultant reduction in viscosity of the oil under treatment. The extent of heating necessary would, of course, depend upon the viscosity of the oil and to a certain degree upon the amount and nature of the contaminating impurities. Obviously, a light turbine oil would not require as much heating as a relatively heavy Diesel engine oil.

The typical centrifugal separator consists of a rotating bowl or cylinder contained within a suitable frame or housing. Oil to be treated is delivered to the top or lower part of the bowl, according to the design. When the bowl is rotated, metallic particles, dirt, sludge, water and oil are separated according to their relative specific gravities, solid matter being thrown to the sides or walls of the bowl. The water and oil are carried upward to be caught in suitable covers which are fitted with spouts for discharge to drain or clean oil tank respectively.



NATURAL GAS BURNERS
As Used in the Southwest

By Haylett O'Neil

APPARENT advantages of natural gas over other fuels have led to its general application in both industrial and domestic lines in the Southwest. One of its most striking advantages is the absence of smoking chimneys, and it is probably true that no other feature draws such favorable comment from the Northern visitors to Texas as the clear air and entire absence of soot and cinders.

In a growing country like the Southwest, where industries have not yet become sufficiently stabilized to justify heavy plant investments, the cheapness of the equipment for burning natural gas has its attraction. In addition the lessened labor is advantageous to the plant owner.

Under such circumstances it follows that responsible utility managers are giving more and more attention to the intelligent handling of this fuel in order that they may secure a dependable supply at reasonable cost and of long life.

Gas is the easiest fuel to burn, and when properly controlled it is probably the safest. The absence of ashes or pumping equipment, necessary with other fuels, eliminates drudgery so that the operator can devote all his efforts toward the efficient control of the fires. Moreover, within the limits of burner, setting and draft capacity, gas is the most flexible fuel. From the user's point of view it offers an advantage in not requiring storage, as this factor is taken care of by the producer.

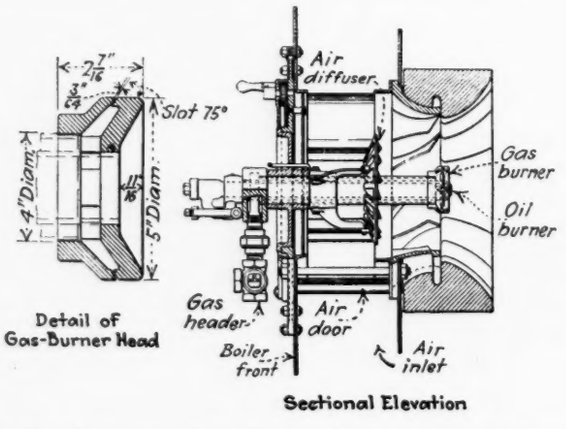


Fig. 1—A combination oil and high-pressure gas burner

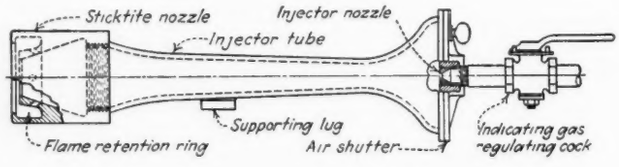


Fig. 2—A burner making use of gas velocity

There are many types of burners available, but in general they may be classed as high- or low-pressure.

High-pressure burners require gas pressures from two to 25 lb. per sq.in. They are principally a development from the mechanical or high-pressure oil burners, and are operated in much the same manner. Usually, they are arranged so that the gas-burner tube can be replaced by an oil tube in case it is desirable to burn oil. As high pressure increases gas density, smaller and cheaper piping can be used than in low-pressure burner installations. This may be a great advantage in a plant with large gas consumption. Efficient combustion at a high rate is also possible with this type of gas burner.

There are, however, some real weaknesses in this type of burner. In order to secure good air-gas mixtures, the diameter of the air openings is usually limited to less than 24 in. A large number of such openings in the firing wall presents a weak support for tons of brickwork weighing 150 lb. per cu.ft. For structural reasons the number of burner openings must be limited.

If the boiler is to operate at low rating, this is not a serious problem, but when the draft losses must be kept low on account of the chimney capacity, it is necessary at high ratings to resort to forced blast, and the added power requirements are not pleasing.

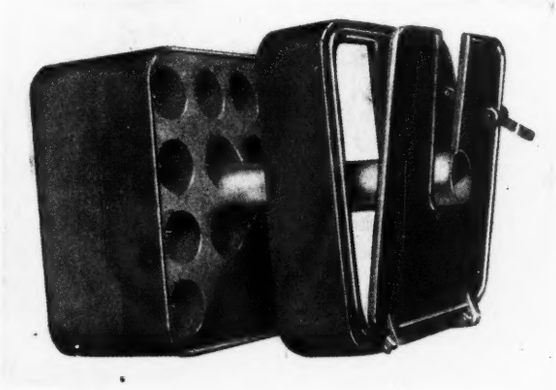


Fig. 3—A multi-jet low-pressure burner

The necessity for high pressure has a fundamentally serious aspect. Suppose a supply line, while simultaneously subjected to a heavy draft, should break. It is certain that the pressure would quickly drop below that necessary to keep the plant in operation. It has been urged by advocates of the high-pressure system that this condition could be remedied by a stand-by compressor system.

A typical high-pressure burner with a combination oil and gas head is shown in Fig. 1. Here the combustion air is forced into the furnace either by natural, or chimney draft, or by forced blast. There is also a slight induction of air by the jetting action of the high-velocity fuel jet.

In another type of high-pressure burner, Fig. 2, a considerable portion of the combustion air is jetted into the furnace by the high gas velocity. This type of burner, in certain small furnace volumes worked at high rates of combustion, has operated satisfactorily on gas pressures of from 5 to 10 lb. gage.

Low-pressure burners usually operate from one-quarter to one pound pressure, maintained by suitable regulators.

The principal disadvantage of the low-pressure system is the higher first cost of the burner and piping. Attempts on the part of some manufacturers to lower installation costs by reducing the sizes result in higher gas pressure and improper air-gas ratios, so that sometimes the gas consumption for a given duty has been as much as 35 per cent over economical requirements.

Certainly, a prime requirement for efficiency is that a burner should have liberal proportions, thus securing plenty of reserve gas capacity and air-passage area. Moreover, in boiler work of any considerable size, it has been demonstrated that the multi-jet or multi-tube burner is the most efficient.

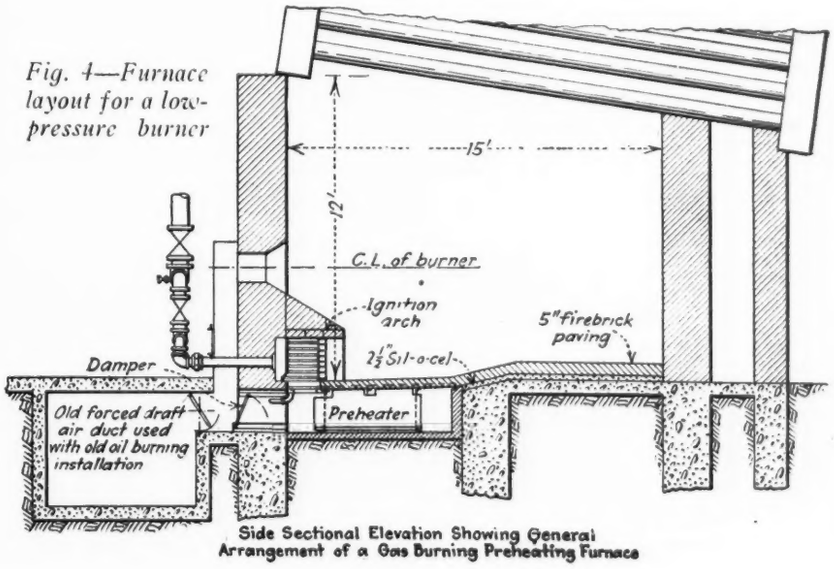
There is nothing inherent in either a high- or a low-pressure burner to limit its capacity to produce steam. All that a burner can do is to pass the required gas and air and efficiently mix these so that they will burn in the furnace. All other conditions being equal, a high-pressure burner can burn more gas in the same furnace than a low-pressure burner because high pressures create higher velocities and hence more turbulence, with a short flame length. A release of 40,000 heat units per hour per cubic foot of furnace volume is the limit of a low-pressure burner.

The structural objections to high-pressure burners being placed in a firing wall apply even more positively to low-pressure burners, which are larger in cross-sectional area, especially if operated entirely with forced draft. An installation of a low-pressure combination oil- and-gas burner which avoids this weakness is shown in Fig. 4. Here, outside of the necessary small peepholes, all the walls above the hearth are 100 per cent solid. The burners, being set inside, support only a slight protective covering of brick, and the air openings are entirely below the firing floor. Therefore, they are not subject to strains or to furnace temperatures on one side and room temperatures on the other. The claims of manufacturers of this equipment of low-furnace maintenance have been substantiated fully by the operating experience among the larger industrial plants in the South. The burner and the air passages are shown in the headpiece.

This arrangement permits preheated air to be applied directly at the burner and furnishes air-cooled protection to the boiler side-wall footings. It permits an efficient oil-burning arrangement, so that a conversion from or to either fuel is possible in two or three minutes. This burner, when fired with the proper air-gas ratio, produces a flame highly luminous, which gives maximum flame radiation, resulting in a high heat transfer through the boiler tubes. The result is lower flue-gas temperatures than result from the ordinary clear, or non-luminous, combustion.

Test results obtained with this low-pressure burner

Fig. 4—Furnace layout for a low-pressure burner



Side Sectional Elevation Showing General Arrangement of a Gas Burning Preheating Furnace

appear in Fig. 5. This plant was formerly fired with high-pressure mechanical oil burners, and a comparison of the present results with natural gas shows that 5,330 cu.ft. of gas is equivalent to one barrel of oil. Two "obtained" efficiency curves are shown. The lower one is based on the high heating value of gas in conformity

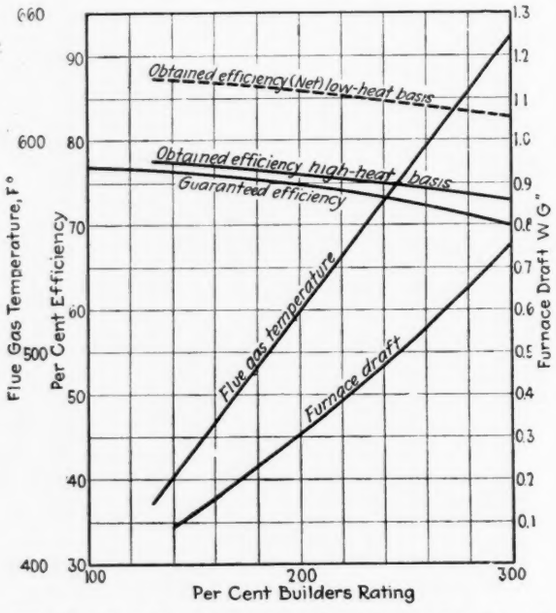


Fig. 5—Results obtained by burner used in Fig. 4

to the A.S.M.E. testing code. The upper is based on the "low," or so-called "net," heating value of the gas.

Another current low-pressure burner of the multiple-jet type is shown in Fig. 3. Usually, this is placed in the front furnace wall level with the furnace floor and has been operated efficiently up to a release of from 130,000 to 150,000 B.t.u. per tube.

Less Waste in Power Transmission

When a motor is coupled directly to the load, its speed must be the same as that of the driven shaft. Many of these drives require slow-speed motors. In general, where high-speed motors can be used they are preferred on account of lower cost and for other reasons. To use a high-speed motor on a low-speed drive, some form of speed reducer is required. In the next issue, an article on "Short-Center Drives," will deal with applications using short-center belts with idlers, belts having a high coefficient of friction, and V-shaped belts running in grooved pulleys.

Spalling of Refractories in Oil-Fired Furnaces

IT has been the common experience of those using fuel oil for firing boilers that the refractories of the furnace fail because of spalling rather than from slagging, whereas slagging is the more common trouble with furnaces fired with powdered coal. The relatively small amount of slagging in oil-fired furnaces is to be expected because the ash content of fuel oil is less than one-tenth of one per cent, whereas that of the coal may be from 8 to 18 per cent; there has been, however, no proved explanation of the very common breaking up of the refractory walls by spalling, although that of strains caused by temperature variation is reasonable.

The boiler furnace refractories investigation, which the United States Bureau of Mines has been conducting in co-operation with the American Society of Mechanical Engineers, has included a study of furnace conditions of two large boilers using Illinois coal and one using fuel oil. The low fusion temperature of the ash of the coals made slagging a serious cause of trouble in the coal-fired furnaces, whereas the oil-fired furnaces showed the usual failures from spalling. A special comparative analysis was made of the measurements taken in the coal- and oil-fired furnaces in the attempt to elucidate the reason for the greater spalling.

The rate of heat liberation in the oil-fired was much higher than in the powdered-coal furnaces, but the maximum temperatures of the gases observed were the same, 2,800 deg. F. The maximum temperatures measured were somewhat higher in the oil-fired furnace at the positions where the flame impinged on the wall.

The temperature gradient plotted for the first six inches of the hot side of the furnace wall under approximately constant operating conditions was not greater for the oil-fired than the coal-fired furnace.

The rate of change in temperature of the furnace walls when the furnaces were banked or fired up was nearly the same. The rate and frequency of change of temperature during steaming were not greater in the oil-fired than in the powdered-coal furnace walls; these measurements were taken at one-half inch and farther from the hot surface, and although they do not predicate the possibility that the small temperature variation at the hot surfaces of the walls were not the same, yet there is not sufficient evidence to warrant the acceptance of change of temperature as the only cause of the greater spalling in the oil-fired furnace.

The chemical composition of the ash of the fuels and of the slags from the walls differed materially in that those from the oil-fired station were higher in sodium and lower in iron and calcium; the softening temperatures were low for all. Microscopic examinations of the slags by the Columbus Station of the Bureau of Standards have shown the presence of a mineral in the oil slag not previously found in coal-ash slag, which has been identified as a sodium-calcium silicate.

It is, therefore, possible that some mineral or minerals formed in the slag or in the combination of slag and brick which was sensitive to thermal shock; or the mineral may have had a much different coefficient of thermal expansion from that of the brick, and fracture resulted from the difference in the contraction of cooling. The relatively deep fractures found on the side and front walls bear out the former conception, and the thin fractures on the bridge wall, the latter.

*How to Avoid Fire In Storing Indiana Screenings**

By M. A. TUTTLE

Combustion Engineer, Knox Consolidated Coal Company, Indianapolis

THERE are four determining factors in the storing of Indiana screenings: The foundation of the pile, the depth of the pile, the segregation of the fines, and the firmness of the pile.

Foundations should be firm and level to permit reclaiming the coal with a minimum of dirt and cinders. They should be free from rubbish or vegetable matter that will hasten spontaneous combustion, and above all, they should be higher than the surrounding terrain to prevent shed water from running under the piles.

Coal in a pile is a poor conductor of heat. Other conditions being equal, it is reasonable to assume that the heat is generated uniformly through the entire depth of the pile. If given a chance, the earth will absorb a large amount of this generated heat, and from the exterior of the pile the surrounding air will carry away heat. The depth of the pile then resolves itself into a question of a thickness such that the earth and air will absorb the generated heat. Readings taken at every foot in the vertical depth of a pile about seven feet deep were as follows:

Ft. of depth,	1	2	3	4	5	6	7
Deg. F.,	121	138	144	142	134	120	106

The pile was started Jan. 31 and the readings taken on July 23. From the figures it would seem that the earth was doing a better job of absorbing heat than the air.

A pile 12 ft. deep that was finished in December showed the following temperatures in January:

Ft. of depth,	4	6	8	10	12
Deg. F.,	154	160	162	166	158

The temperatures had been increasing at the rate of about ten degrees a week, sc the pile was moved. Although put down in an excellent manner, it was evident that the pile was too deep to radiate the heat as fast as it was generated.

SEGREGATION OF THE FINES

The slow oxidation of the emitted gases that causes the heating takes place at the surface of each particle of coal. Any increase of temperature quickens the distillation of these gases, and if the necessary oxygen is present, further heating takes place. This cycle of acceleration continues until the coal fires at about 400 deg. F. One ton of $\frac{1}{16}$-in. mesh screen coal has an exposed surface of one acre, or about 945 times the surface of a cube of coal weighing one ton. If segregated, the fines have such a large exposed oxidizing area per unit of volume that they will heat up if oxygen is present. The lanes or streaks of nut coal furnish the necessary ventilation to hasten the combustion of the fines.

This action was well demonstrated in a pile containing about 54 cars of coal. The pile was put down in a vacant lot by a two-ton dump truck. Two men worked on the pile at all times to level each dump. After the pile had been completed, an addition was made by driving up on the pile, turning the truck and dumping over along one end. The coal rolled down about six feet, and fines and lump divided as perfectly as though a screen had been used. Fire developed along this edge of the pile, and the coal had to be moved and quenched with water.

FIRMNESS OF THE PILE

Firmness is one of the primary essentials. The firmer the pile, the less possibility there is for a free passage of air, and possibly a firmer pile is also a better conductor of heat.

In a certain pile used for both temporary and permanent storage, the foundation had been made of concrete and had a slope so that the drainage was perfect. In dumping, the coal was tumbled down the incline and was helped along by shoveling. This method left the pile loose and divided, so that this storage pile always caused trouble from firing.

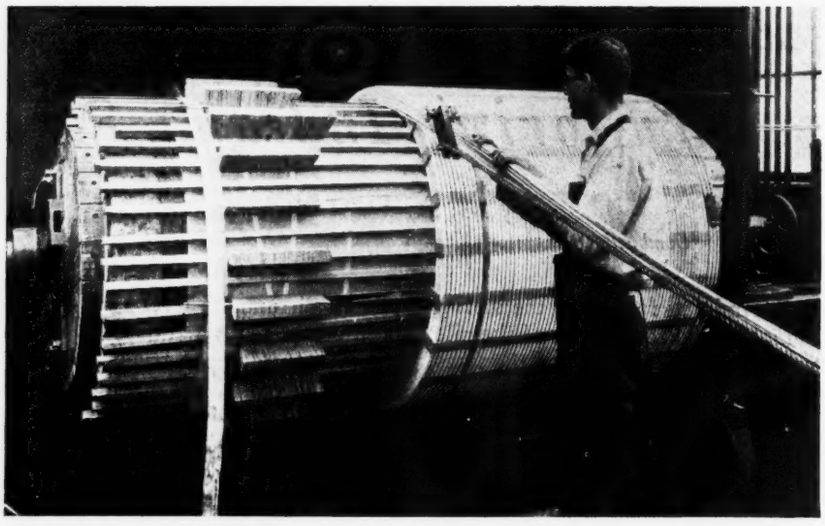
One large user of steam coal in Wisconsin needed both a temporary and a permanent storage pile. The temporary storage was necessary owing to the long haul and the tendency for current shipments to be bunched. The permanent pile was needed to take care of transportation tie-ups during the winter. This company had been having trouble with the permanent pile owing to pyramidal piling by means of a locomotive crane and a clamshell. As they were receptive to suggestions, the foundation for the new pile was raised above the surrounding terrain and railroad rails laid in the cinders, so that the coal could be reclaimed without digging into the bottom. About 2,000 tons was put down and kept uniformly level, but the coal was not packed.

The pile was started the first week of September, 1926, and finished about Oct. 15. By the middle of November, after a light snow fall, steam was seen rising from the pile, and in January it fired at two places, so that it was necessary to reclaim the entire pile.

Having a well-prepared and accessible plot for storage, there are several methods of putting down the coal. One cheap and satisfactory way is to unload it from the car and drag it back by means of horses and a slip drag or scraper. This keeps the pile level and free from segregation. Horses do not make a beaten path, but keep the entire pile well packed. Another method that has given satisfaction is to unload by means of a locomotive crane and use a small tractor and steel drag to pack and level the pile.

Piles of two or three layers often are put down by small dump trucks. The first layer is dumped on the ground and should be leveled off. The packing of each layer is done by the truck by which the next layer is placed. This method limits the amount of coal stored per unit of area, but it would seem better to have a limited amount of coal stored well than to have a larger amount stored, but on fire in the pile at a later date.

*Extracts from a paper read before the Indiana Fuel Conference, Purdue University, 1928.



Winding the low-voltage coil of a 22,000-kva. transformer

UNIFORM TEMPERATURE . . . . SUBSTANTIAL INSULATION
MECHANICAL STRENGTH

Features of Transformer Coils

By Charles A. Armstrong

A LARGE percentage of power transformers have two independent windings insulated from each other. For certain classes of service auto-transformers are used, in which the primary and secondary windings are connected. These are used where the voltage ratio is low. For example, for starting alternating-current motors on reduced voltage, the starting voltage is seldom less than 60 per cent line volts and is frequently as high as 85 per cent. In either case the ratio of primary to secondary volts is low.

Another application of auto-transformers is on generators, to increase the voltage for transmission. An instance of this is where the generator is designed for 11,000 volts and an auto-transformer is connected to the generator terminals to step the voltage up to 22,000 for transmission. Auto-transformers are sometimes used to tie together two transmission systems having different voltages, such as 66,000-volt lines into one of 110,000 volts.

When the ratio of the primary to the secondary volts is more than two or three to one, the two windings are usually insulated from each other. This is for safety, to simplify insulating the low-voltage winding and to keep down the cost. If the low-voltage winding of a 6,600- to 230-volt transformer were connected to the high-voltage winding, both would require the same insulation. With a connection between the two windings the high voltage presents a serious hazard to anyone coming in contact with the low-voltage equipment supplied from the transformer. To insulate the low-voltage winding to operate on the high voltage would increase the cost of construction.

About every form of coil has been used in transformer construction. They are made square, rectangular, round and elliptical, depending on the size and type of the transformer and on the inclinations of the designer. These coils are wound with round or square copper wire, or rectangular strips. The latter may be wound flat or on edge. Round copper wire larger than No. 10 B. & S. gage is seldom used, since the space factor of the wire in the coil is poor. This size wire has a diameter of about 0.1 in. Square wire smaller than this is not generally used, because it has a tendency to turn on its edges and cut the insulation. This fault is particularly noticeable at the end of the coil when going from one layer to another. Square conductors are economical of space. About 25 per cent less space is required for the same copper cross-section using square conductors than when round are used. Large rectangular conductors are economical of space, but in small sizes this

There are a great many types of coil construction, methods of insulating and arrangement of oil ducts used in power transformers. This article gives a general review of the different types of construction and is a companion story to "Types of Cores" in the October 30, 1928, issue.

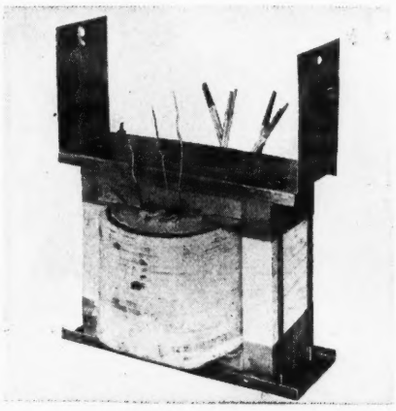
advantage is lost because of the insulation between them. With thin conductors the insulation between turns may exceed the copper in thickness. In other words, less than one-half of the winding space would be occupied by copper. Not only has this the bad effect of using space uneconomically, but the coils do not dissipate heat readily. Like small square conductors, the edges of the rectangular form are liable to cut through the insulation.

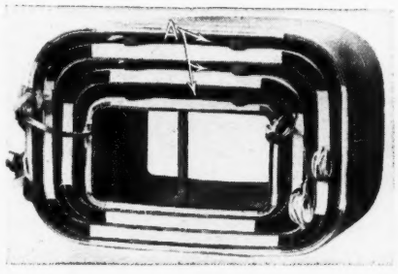
Conductors used in transformer coils may be insulated with a single cotton covering, a double cotton covering, paper, enamel or a single cotton covering over enamel. Insulation used on the conductors or in coil construction must be impervious to oil, since in general the coils are immersed in a tank of insulating oil. Additional insulation value is the chief reason for using cotton-and-enamel covered wire instead of cotton- or paper-covered.

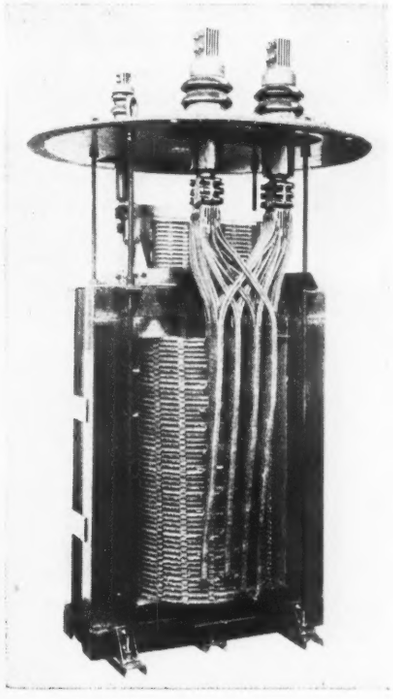
The oil in the transformers has two functions, one to act as an insulating medium, and the other, to transmit the heat from the coils to cooling medium. This medium may be the surface of the tank, to cooling coils, radiators or other devices, or a combination of two or more of these. Therefore, the more readily the oil can circulate around the coils the easier it can carry away the heat.

Mechanical strength must be provided in transformer coil designs, to withstand the severe stresses they may be subjected to during short-circuits and other disturbances.

Forms of coils used in transformers vary widely with the core arrangement, the voltage, size and other factors. The coils are of two general types, core wound and form wound. Core-wound coils are used on some makes of small, low-voltage transformers. In this construction the core is used as a foundation for winding the coils. After







Figs. 1 to 4—Forms of transformer coils and assembly on the core

Fig. 1 (Upper left)—Coils assembled on the core of a small transformer. **Fig. 2 (Lower left)**—Group of form-wound coils. The inside and outside coils are the low-voltage and the two coils between are the high-voltage. The coils are assembled with ducts *A* between them for the free circulation of oil. **Fig. 3 (Center)**—Coils assembled to provide both radial and axial ducts to bring the oil in contact with practically every part of the winding. **Fig. 4 (Right)**—Coils and core assembled for a 2,000-kva., 2,400- to 480-volt transformer. How the low-voltage connections are brought out from the coils and grouped up to the terminals is shown in the figure.

Enamel has a dielectric strength of 600 volts per mil and is therefore superior to fibrous insulation of the same thickness. This allows a thinner insulation than can be used for double-cotton covered wire. Enamel will withstand high temperatures better than fibrous insulation; it is tough and impervious to moisture. Impregnating the coils wth insulating compound has a beneficial effect on fibrous insulation to resist higher temperatures and to increase its mechanical strength. For winding the coils, conductors insulated with enamel or fibrous material are widely used.

When current flows in the windings, it produces heat that must be removed as fast as created, or a temperature will develop that will destroy the insulation. This is important in the design and winding of the coils. The shorter the distance the heat has to flow in the conductors before it reaches the oil, the lower the temperature of the winding will be for a given load on the transformer.

the core is insulated, the low-voltage winding is wound on. An insulating barrier is placed over the low-voltage winding, and then the high-voltage winding is wound over this.

In some constructions the low-voltage winding is divided into an inner and an outer section. With this arrangement the inner section is wound on the core, then an insulating barrier is put over it and the high-voltage winding put on. Over the high-voltage winding is wound the outer layer of the low-voltage winding. Ducts are usually provided between the different coils for the free circulation of the oil to carry away the heat developed in the copper. In some cases the high-voltage winding may be wound in two sections with an axial oil duct between the sections, as is also provided between the high- and the low-voltage windings.

Instead of the coils being wound on the core, small transformers are also constructed with form-wound coils.

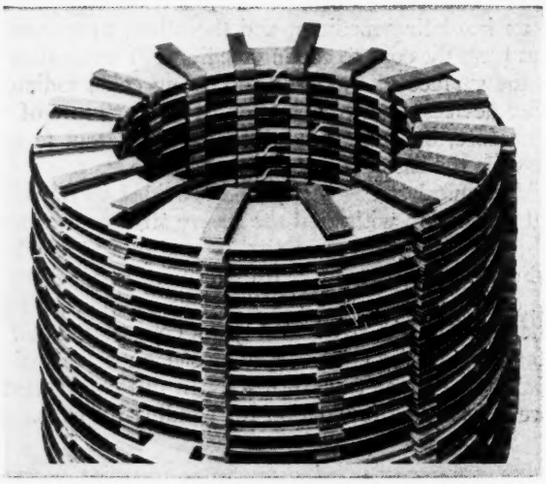


Fig. 5—Stack of circular disk coils wound with rectangular conductors having a width equal to the coil's thickness

The high- and low-voltage coils may be wound separately on forms and assembled in a unit, with spacers between the different sections to provide oil ducts, as in Fig. 2. After the coils have been grouped and insulated, they are put on the core or the core built around the coils, depending on the type of core used.

In other makes of transformers the windings are all wound on one form, the same as for the core-wound type. With this arrangement the winding is wound up as a unit, the insulation barriers and oil ducts being provided when the coils are wound one over the other. Transformers of this type are usually limited to about 100-kva. capacity or less. There is, however, one manufacturer that uses this construction for the largest transformers.

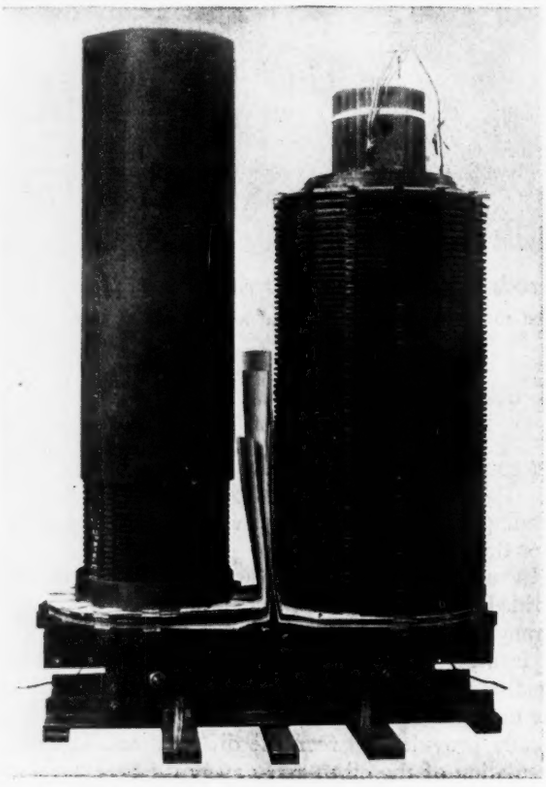
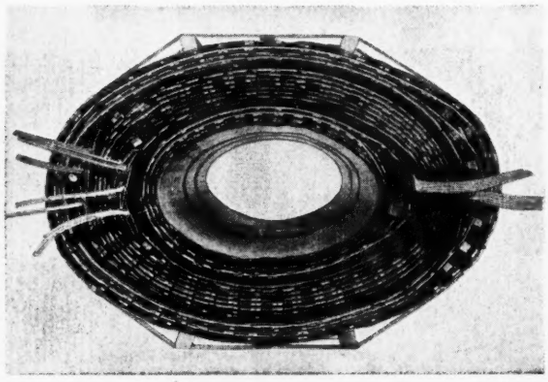


Fig. 6—Coils and core partly assembled

On the left leg the low-voltage coils are in place on the core and the insulation cylinder is partly lowered over them. The cylinder forms an unbroken insulation barrier between the low-voltage and high-voltage coils, the latter being shown in place on the right hand leg of the core. The coils used in this design are of the circular disk type shown in Fig. 5.

In the larger transformers the problem of providing proper cooling facilities of the coils is an important one. To do this, it is common practice to wind the coils in short thin sections with spacers between them. These sections are then assembled with radial spacers to form one leg of the winding, as in Fig. 3. The vertical and radial ducts provide for free flow of the oil about all sections of the winding, so that the temperature in the copper is nearly uniform. Modern transformers are constructed so that the hottest spot in the winding is only three or four degrees above the normal temperature.



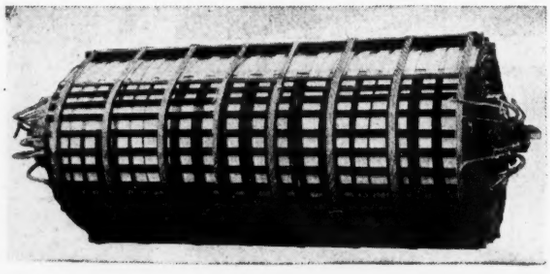


Fig. 7 (Above) and Fig. 8 (Below)—Show end and side views of an elliptical coil assembly

This is one of three coil groups for a 15,000-kva. three-phase transformer. The coils are wound as a unit. First one-half of the low-voltage winding is wound on, then the high-voltage coils are wound, over which is placed the second half of the low-voltage winding. The coils are wound in layers with suitable insulation and oil ducts between them.

In Fig. 3 the low-voltage winding is on the inside and the high-voltage on the outside, with an insulating barrier and oil duct *A* between the two.

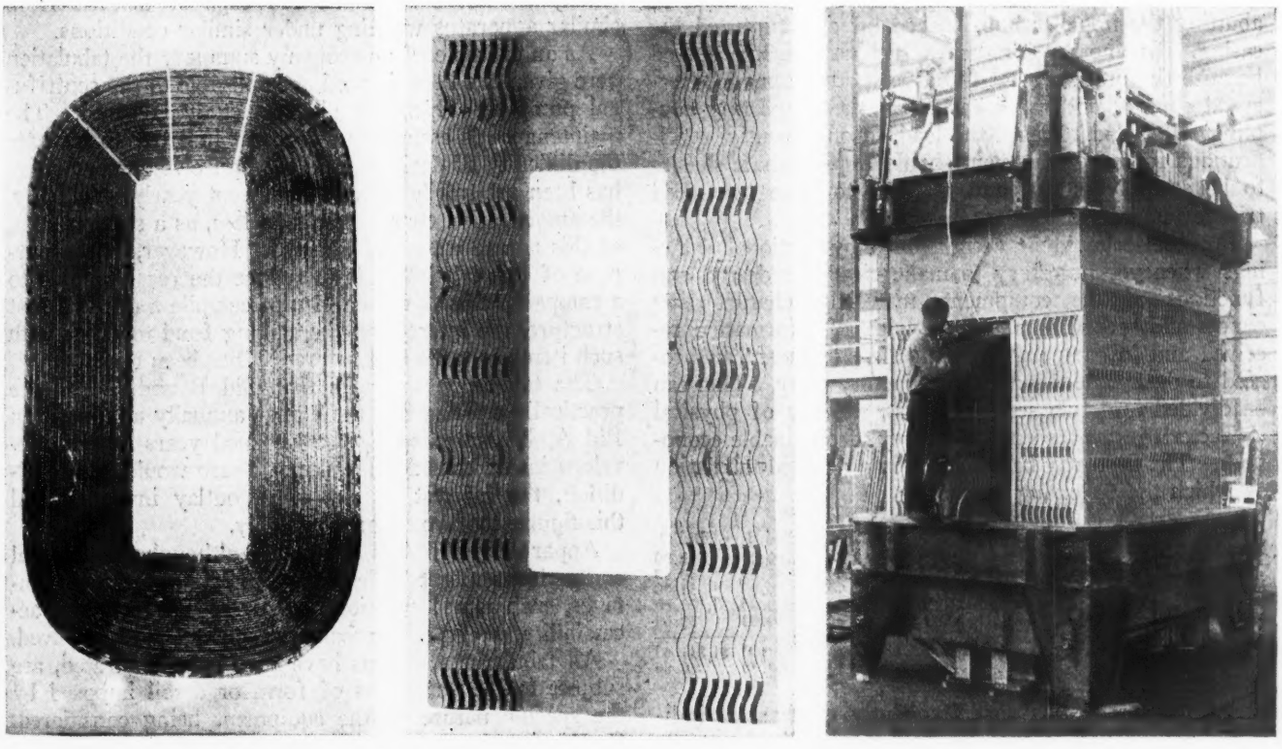
Another method of obtaining large coil surface exposed to the oil is to use circular disk coils as in Fig. 5. The thickness of the disk is rarely more than one-half inch. The coils are wound with strip copper that has a width, including its insulation, equal to the thickness of the coil. The coils, being wound circular, have the appearance of a spiral.

In some designs both the high- and low-voltage coils are wound as in Fig. 5, and when the windings are assembled on the core the coils of the two windings are interleaved. The coils are arranged in groups and are then stacked by alternating the low-voltage groups with the high-voltage. Radial oil ducts are provided by suitable spacers between the disks. These radial ducts connect to vertical ducts at the inside of the coils. By this

arrangement the oil not only comes in contact with each turn in the coils, but also has free circulation.

For other designs the low-voltage coil is wound on a cylinder of insulation. If this winding has two or more layers, oil ducts are provided between them. The headpiece shows the low-voltage coil being wound for a 22,000-kva. transformer. This winding has a helical form, with relatively deep convolutions in proportion to the coil's diameter. Each turn of the helix consists of a number of separately insulated conductors in parallel for the reduction of eddy currents. All conductors of each turn are supported at frequent intervals by spacers locked into position, with vertical spacers bearing against the inner insulating cylinder. A circular disk-type high-voltage winding is used, as in Fig. 5, supported by spacers at right angles to the turns. The radial and axial ducts are used. The spacers are to allow free circulation of the oil. A wave spacer and insulation washer used by one manufacturer is shown in Fig. 10. When the winding is assembled for the core, spacers are placed around the coils as in Fig. 11, to allow circulation of oil between the coils and the core.

The coils are arranged vertically with at least one side exposed to the cooling medium. The shape of the wavy spacers is such that each conductor is braced against short-circuit stresses and each conductor is in intimate contact with the cooling medium. The portion of the conductor blanketed by the wavy spacer is a small percentage of the total coil surface and is connected by the heavy copper section with the portion of the conductor that is exposed to the oil. The ready conduction of heat along the copper reduces the temperature difference



Figs. 9 to 11—Coils and insulation used in one design of shell-type transformers

Fig. 9 (Left) — Rectangular disk-type coil. **Fig. 10 (Center)**—Insulation washer and wavey spacer used between the coils. **Fig. 11 (Right)**—High and low-voltage winding assembled ready for the core. Around the outside of the winding wavey spacers are also placed to allow free circulation of the oil between the core and coils.

provide free circulation of the oil around the coils to maintain uniform temperatures in the copper.

Fig. 7 shows an end view of the complete winding for one leg of a 15,000-kva. transformer. These coils are elliptical in cross-section, and the winding is of the cylindrical or barrel type. First, one-half of the low-voltage winding with suitable spacers is wound on an insulation cylinder having an elliptical cross-section. Over this winding the high-voltage coil is wound and insulated, after which the other half of the low-voltage winding is wound on the outside. The winding is wound in thin layers, with ducts between to provide for free circulation of the oil.

In large shell-type transformers disk-type rectangular coils are used, Fig. 9. These coils are wound with an insulated copper strip equal to the thickness of the coil. When the coils are assembled into a complete winding, the low-voltage coils are interleaved with the high-voltage. Between each two coils an insulating washer and spacers between the blanketed and exposed sections and tends to produce a uniform heat gradient.

After transformers are assembled, it is general practice to subject them to a drying and insulating process. They are first heated in an oven to drive out the moisture. Then they are placed in an impregnating tank in which a vacuum has been established. After the windings have been thoroughly dried out, insulating compound is admitted to the tank under pressure. The air and moisture having been removed from the coils, they become saturated with the compound. The coils, after being in the compound for some hours, are removed and allowed to cool. In this way the winding is sealed against the entrance of moisture. In some cases only the coils are given this treatment.

Photographs in this article were supplied by the General Electric Company, Kuhlman Electric Company, Allis-Chalmers Manufacturing Company and Westinghouse Electric & Manufacturing Company.

Helpful Suggestions in The Purchase of Equipment

By R. H. EMERICK

REQUESTS for bids should be accompanied by all possible information and data on the construction desired, the results expected and range of conditions throughout which the equipment must operate. The operating personnel is of inestimable aid at this stage. They can often make suggestions that will add little or nothing to the purchase price, yet save substantial maintenance expense.

The writer recalls a check-valve failure that set a centrifugal pump to running backward with the result that a bronze shaft sleeve, threaded to the shaft at a point abutting the impeller hub, backed off and ruptured the casing. In another instance a turbine wreck occurred because the unit was not fitted with an automatic overspeed shutoff, and ran away when the connecting coupling failed and released the load. Consequently, specifications for new equipment should require shaft sleeves to be securely pinned and turbines to have overspeed trip devices.

Proposals should be accompanied by sectional drawings whenever necessary to make clear the design and functions of the equipment, materials, characteristic curves and special data. Then, with all information received and in comparable form, the purchaser can proceed to determine the most satisfactory offer. This can be divided into two sections—first, a study of physical characteristics and, second, a survey of obtainable economies. The first may be set down in a detailed tabulation of which the following is typical:

	Bid A	Bid B	Bid C
Price (quoted)	$550.00	$700.00	$510.00
Interest (6 per cent investment)	33.00	42.00	30.60
Amortization (10 per cent annually)	55.00	70.00	51.00
Power charge (estimated from curves)	1,250.00	1,070.00	1,100.00
Maintenance (estimated)	50.00	50.00	50.00
Total yearly cost	$1,388.00	$1,232.00	$1,231.60
Yearly difference	—$156.40	—$0.40	$0.00

A collation of this sort frequently emphasizes individual advantages. General advantages or disadvantages of design may be determined by a study of the drawings, which will reveal convenience in the repacking of glands, difficulties in replacing wearing rings, the locations of pipe connections, etc.

This section of physical characteristics should include notations of the maximum efficiency obtainable and important horsepower ranges. It sometimes happens that driven apparatus possesses a horsepower characteristic that goes up and up until it exceeds even the temporary overload limit of the prime mover. Obviously, designs of this kind should be either avoided or compensated.

The second step, that of economy studies, should treat the equipment over its full span of life. How long that life may be is a matter of individual practice in retirements. Whatever its life, there should have been accumulated before its end, a sum of sufficient magnitude to install a new unit in place of the old. This sinking fund, or amortization, being built up usually by annual increments, must be considered as a charge against the apparatus. Other charges to be considered are: Interest on the initial investment; the power charge, which must be based on the manufacturer's guarantee of efficiency; and probable maintenance expenses, which must be either wholly estimated from the drawings or derived from similar apparatus working under similar conditions.

As an example of an economy summary the tabulation here given has been formed as applicable to the centrifugal pump on which the physical study is based. The maintenance is assumed as constant in order to increase the difficulty of decision, and the figure for amortization has been arbitrarily set at 10 per cent yearly. Actually, the amortization charge would be less, as a sinking fund of this nature would be invested. However, as the purpose of this tabulation is to reduce the received bids to a comparable basis rather than to compile a detailed cost structure, the interest on the sinking fund together with such items as taxes and insurance, has been omitted.

The tabulation indicates that Bid B and Bid C are practically equal, while the excess annually attendant on Bid A, if multiplied by the assumed years of life, develops into a considerable sum. There would be, in addition, the interest on the extra outlay involved, and this figure, too, would grow steadily.

Apparently, Bid A is eliminated, although the physical comparisons might indicate that certain valuable advantages, such as conservation of floor space or unusual accessibility, would counterbalance the extra costs involved.

All tabulations such as have been here illustrated, are subject to the variations of form or detail imposed by the specific nature of the equipment being considered. Certain items, such as pressure and vacuum gages, various indicating and recording meters, traps, tanks, etc., do not entail power consumption at all, while others, like strainers, water softeners, ash cutoff gates, etc., may or may not require power for their operation either directly or indirectly. This fact should be kept in mind and the tabulations modified to meet particular limitations and conditions.

PHYSICAL TABULATION

Proposals For General Service Pumps

(Date)

Mfgr.	Type	Shaft		Wearing Rings		Capacity	Speed	Hp.	Eff.	Bearings		Thrust Bearing		Size of:	
		Material	Diam.	No.	How Replaced					Length	Oil Rings	Type	Remarks	Suction	Discharge
A B C					(Screwed, riveted or pressed on.)	(G.p.m.)	(R.p.m.)		(Per Cent)		(Number)	(Ball, iron shoe, Kingsbury)		(Pipe connct)	

Mfgr.	Space Req.			Weights			Bearing Cooling Water Required	Size of Priming	Coupling		Glands		Time of Shipm't
	Length	Width	Height	Pump	Bedplate	Total			Type	Material	Rings	Kind	
A B C							(In g.p.m.)	(Pipe connect)	(Flex. or rigid)		(No.)	(Mat.)	(Days or weeks)

GENERAL REMARKS

(Cover miscellaneous points of interest that cannot be conveniently tabulated.)

WIRE ROPES FOR ELEVATOR SERVICE

REQUIRE:

1. Flexibility
2. Medium Strength
3. Wearing Qualities
4. Resistance to Crushing

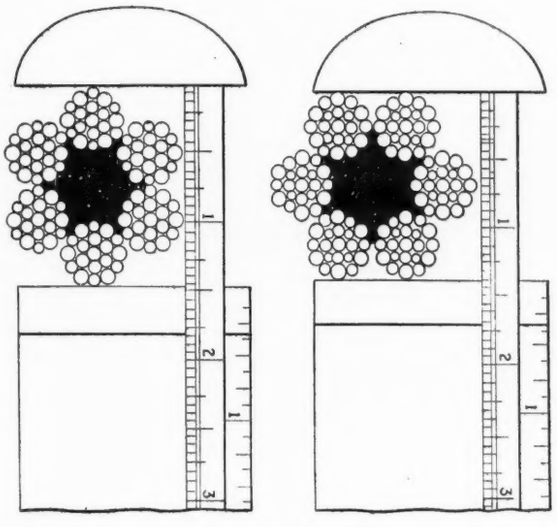
By F. A. Annett
Associate Editor, Power

ROPE replacement is a major operating expense on modern high-speed elevators, therefore careful consideration should be given to rope selection, installation and care. It is important that proper ropes be selected for an elevator, but it is of even greater moment that the conditions be right under which they are installed and maintained. Defective sheaves and other conditions can destroy the best ropes in a short time. Although the selection of ropes will be discussed in this article, it should not be concluded that this is the paramount factor in obtaining long life from elevator ropes.

When ordering ropes the specifications should include:

1. Number of pieces and the length of each piece.
2. Diameter.
3. Type of construction and lay.
4. Grade.
5. Class of service for which used.

The number of pieces of rope for an elevator varies according to what the rope is used for and the type of machine. The length of the ropes depends on the rise and how the machine is roped to the car and counterweights. When the length is not known, it must be obtained by measurement or from the elevator manufacturer.



How to measure the size of wire rope
Fig. 1 (left)—Correct diameter.
Fig. 2 (right)—Incorrect diameter

If the car has a capacity plate on it, as required by the Safety Code for Elevators, the size of the ropes can be obtained from this. Otherwise, if the diameter is not known, it will have to be measured. Some wire ropes are made so that their external surface is almost a true circle, in which case they have practically one diameter. For the ropes generally used on elevators this is not true, and there is considerable difference between their maximum and minimum diameters. The maximum diameter, Fig. 1, is the correct one to use when specifying wire rope. In other words, the diameter of a rope is the diameter of the minimum circle through which it can be passed.

A used rope will have a smaller diameter than it had when new, due to the bedding of the strands into the hemp center, to stretching and to wearing of the strands. The sizes of hoisting ropes between two and $\frac{5}{8}$ in. in diameter are generally in steps of $\frac{1}{8}$ in. If the diameter of an old rope is found to be $\frac{1}{16}$ in., this dimension is $\frac{1}{16}$ in. less than $\frac{3}{4}$ in. and greater than $\frac{5}{8}$, therefore it will be safe to assume that the rope was $\frac{3}{4}$ in. in diameter when new. Below $\frac{5}{8}$-in. in diameter, wire rope changes sizes in $\frac{1}{16}$-in. steps. For elevator service the sizes most commonly used for hoisting purposes are $\frac{1}{2}$ and $\frac{5}{8}$ in. in diameter or larger. Operating and governor ropes are usually $\frac{1}{2}$ in. or less in diameter. It is important that the correct size be selected, since an oversize or undersize rope will have a short life.

With the exception of the 6x42 tiller all the constructions, Fig. 3, have been used for elevator hoisting ropes. Present tendencies seem to be toward the use of either the Warrington or the Seale types. Iron ropes of the 6x19 regular or Warrington constructions at one time were used almost exclusively for hoisting, counterweight and governor service on drum-type machines. They are still in wide use, but for the drum-counterweight ropes on basement-type installations 6x37 or 8x19 mild steel is also used with satisfactory results. On these machines the counterweight ropes have a reverse bend in them as they lead off the drum and up the hoistway. In some cases this bend is short, but even under the most favorable circumstances a reverse bend causes much faster fatigues of the wires in the rope than when all bends are in the same direction. Experience with 6x37 or 8x19 mild-steel ropes for these conditions has shown good results. Mild-steel ropes of the 6x19 construction are sometimes used for car-hoisting service.

In general, drum-type elevators are used on comparatively short rises, and run at slow speeds in service where they are not in continuous operation. As a result the car mileage per year is comparatively small and the ropes

may operate for ten years or more before replacement is necessary. With traction machines conditions are in general quite different from those for the drum type. The cars frequently operate at high speeds and are in continuous operation for nine or ten hours per day, consequently the car mileage per year is high and the wear on the ropes accordingly. Traveling 10,000 miles or more per year is not uncommon for high-rise express cars. To the increased wear and fatigue due to high yearly car mileage must be added the effects of slippage and wedging actions of the ropes in the traction-sheave grooves. These conditions impose severe service on the ropes of traction machines.

For this service mild-steel ropes of various constructions are used, iron being unsuited. Mild-steel ropes are sold under various trade names, such as traction steel, special traction steel, toughened steel, etc. All, however, are made of a steel specially treated to make it suit the service conditions existing on traction elevators. Ropes of the Warrington type have been used extensively on traction machines, but there is a tendency toward more flexible constructions. One manufacturer recommends, for full-wrap type traction machines with sheaves over 29 in. in diameter, a 6x19 construction with six small spacer wires in each strand, making a 6x25 construction. For full-wrap traction machines with sheaves under 30-in. in diameter, all V-grooved-type traction and machines with 2 to 1 roping, an 8x19 Seale

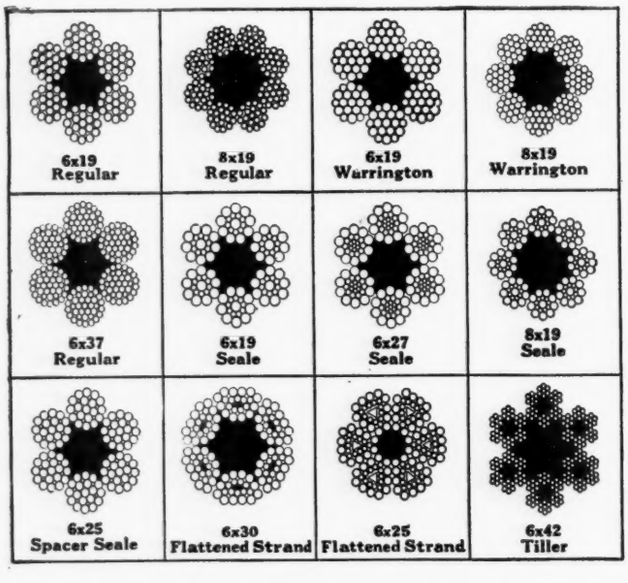


Fig. 3—Cross-sectional arrangements of different rope constructions.

construction is recommended. All these ropes are made of a special traction steel. These recommendations are similar to those of another manufacturer making a toughened-steel rope.

Experience appears to justify the use of the more flexible ropes, such as the 8x19 Seale construction. This gives a flexible construction with large wires on the outside of the strands to stand wear.

Until recently, practically all governor ropes used were 6x19 or 6x42 iron. Mild-steel ropes of the 6x19 and 8x19 constructions are now being used quite extensively. The tail rope, connecting the drum on wedge-clamp type safeties to the governor cable, is frequently made of bronze. This piece of rope is seldom in use and, if not looked after, may become badly rusted and weakened. Using bronze rope for this service eliminates the rust hazard, so far as the rope is concerned. Of course, if the safeties are allowed to become rusted so that they cannot be applied, a bronze tail rope is of

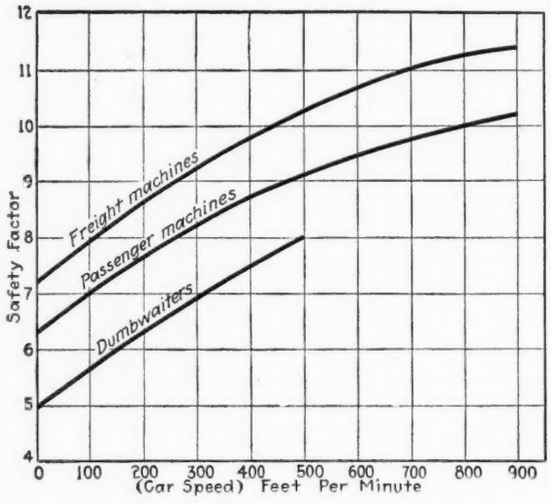


Fig. 4—Factors of safety for hoisting ropes, based on the Standard Code for Elevators.

The code recommends for traction-machines, factors of safety 25 per cent in excess of the values given in these curves to allow for wear on the ropes.

little use. For compensating cables both 6x19 and 8x19 steel or iron constructions are used.

Regular-lay right-lay is the one usually recommended. Although Lang-lay rope offers a greater wearing surface to the sheave grooves, it is more difficult to handle than regular lay and has not come into general use for elevator service.

In wire rope as usually made, the strands and the wires in the strands have a tendency to unlay if released. This is the conventional construction that was used exclusively until a few years ago. There is now in common use, what is known as preformed rope. The wire in the strands and the strands are formed as they are laid so that the rope does not have a tendency to unlay.

The strength of rope does not usually come into the problem of selection. As the equipment is usually designed, the safety factor of the ropes is above that recommended by the Safety Code for Elevators. These factors of safety are shown by the curves, Fig. 4. As mentioned in the previous article (Jan. 15 issue) the breaking strength of wire used in rope varies from about 85,000 to 280,000 lb. per sq.in. Flexibility, medium strength and ability to withstand wear are qualities required in rope for traction elevators. These can be obtained with wire having a breaking strength of about 150,000 to 170,000 lb. per sq.in. High-carbon, high-strength steel wire is too brittle to stand the bending encountered in elevator service. It is also so hard as to cause rapid wear of the sheave-grooves. For these reasons high-carbon steel ropes are not suited to elevator service. The material used has been selected to obtain those qualities that will provide the necessary strength and at the same time produce a rope that has a long mileage life and causes only small wear on the sheave grooves.

The selection of elevator ropes is closely allied with the factors that affect their life, which will be the subject of the next article.

Boiler-Flue Gases Are Converted Into Dry Ice

By G. Grow

GASES issuing from most power-plant stacks may be called a nuisance, but the gases from one boiler plant have been given a commercial value by being converted into frozen white carbon dioxide, the so-called "dry ice."

This dry ice is obtained by separating the carbon dioxide or carbonic-acid gas from the other constituents of boiler gases. The CO_2 gas is then compressed to about 1,100 lb. pressure and upon being cooled it liquefies. By expanding the liquid through an orifice a snowlike mass of crystals results.

Heat absorption by an evaporating substance is the explanation of the CO_2 snow. A similar action occurs in India where, if on a clear night water is placed in a shallow dish, ice will form. To evaporate, a liquid must have added to it the latent heat of vaporization, and if no other source is more available, the part of the liquid that evaporates absorbs this heat from the remainder of the liquid. The temperature of the liquid must, of course, drop, and finally it reaches the freezing point, and on further loss of heat the liquid congeals.

Owing to the inclusion of gas the frozen CO_2 is fluffy and snowlike until it is compressed.

This snow has a temperature below —100 deg. F., and in the sublimation, or vaporization directly from the solid without an intermediary liquefaction, over 200 B.t.u. per pound of CO_2 is absorbed from the articles to be refrigerated. True, this is more than the 144 B.t.u. taken up in the melting of a pound of water ice, but this advantage alone is not enough to justify the increasing use of frozen CO_2, which costs far more per pound than does water ice.

It happens that the gas resulting from the vaporizing of the CO_2 is heavier than air, and if the dry ice be placed above the package under refrigeration, the dense gas will settle down around the sides and so provide insulation against the outside air. If the dry ice is placed below the package and air currents are permitted to blow the gas away, much of the refrigerating advantage is lost.

In the commercial dry-ice plant, coke is burned under a boiler and the steam generated is used in the engines driving the dry-ice machinery. The gases are forced through an economizer, which reduces the flue-gas temperature, and then enter a scrubber. This apparatus, consisting of tanks filled with traprock, cools the gases to a still lower temperature. The next step is the passage of the gases to absorbers, when a solution of sodium carbonate trickles down through a bed of coke and, by absorbing the CO_2 in the flue gases, changes into sodium bicarbonate. This carbonate is pumped to generators where exhaust steam from the engines heats the liquid sufficiently to drive out the CO_2 and the liquid changes back to sodium carbonate.

The CO_2 is then compressed to a pressure of about 1,100 lb. per sq.in. in three-stage compressors. The cooling in the aftercoolers is sufficient to liquefy the gas and the liquid is run directly into steel cylinders of the type seen around soda fountains.

It would be possible to ship the liquid in the cylinders and permit the users to make the dry ice as needed. But a cylinder holding 50 lb. of CO_2 has a tare weight of 100 lb. The freight charge, including the return charge on the empty cylinder, is high, since payment is made on 250 lb., although but 50 lb. of CO_2 is handled. This led to the manufacture of the frozen CO_2 at the factory and its shipment in light wooden boxes.

A familiar laboratory experiment is the making of snow from liquid CO_2. If the valve on the CO_2 cylinder is opened slightly, the liquid rushes on through the opening and a part congeals. The CO_2 snow travels along with the vapor and will finally evaporate if a bag is not placed over the valve to catch the snow, which amounts to about 10 per cent of the original weight of liquid. When manufacturing CO_2 snow commercially, an identical process is followed. To increase the recovery the liquid is cooled by vapor that has previously been formed, and this heat interchange enables about 30 per cent of the liquid to change to snow.

The liquid is fed through a small orifice into a tank. After the tank becomes coated with snow, it is opened and the contents shoveled out. To reduce the volume of a given weight of the frozen CO_2, the snow is compressed into molds, for this increase in density materially reduces the rate of evaporation during shipment. The blocks are placed in balsa wood boxes for transportation.

The Efficiency of Superheaters

By W. E. Warner

SUPERHEATED steam has many advantages over the saturated steam supplied direct from the boilers. Superheaters are placed in the direct path of the heated flue gases, but it is important to avoid the direct action of flame, or the tubes will be burnt out.

When flame is allowed to play continually on superheater tubes, burning out is only a matter of time. The flaming overheats the tube metal locally.

The direct action of a flame on any metal surface tends to burn it. If there is a danger of flame reaching the superheater, baffles, etc., should be arranged to deflect the flame.

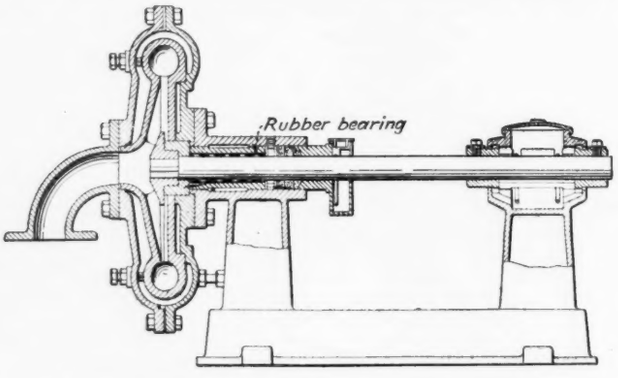
The positions of superheaters should be such that flame cannot reach the tubes, but in some cases this happens, as when a more flaming coal than usual is burned. Another cause of overheating is a deposit on the inner surfaces of the tubes. The action of deposit in the tubes is similar to that of scale on boiler plates. This deposit is derived from the steam. As moisture in the steam is evaporated in the superheater, any solids held in suspension are left in the tubes. Priming may carry much water into the superheater. This also assists in scale formation. Filling the superheater with water to prevent its being overheated when starting a boiler is another cause of scale formation. Deposit due to moist steam can be avoided by installing a water separator between the boiler and the superheater. This will prevent any moisture reaching the superheater. It has not usually been considered necessary to install a steam separator before a superheater, as any moisture in the steam would be evaporated in the superheater; but as a superheater's proper function is to superheat steam, not evaporate moisture, a water separator before the superheater will increase its efficiency.

Blowing steam from the drain cocks of the superheater helps to remove sediment. Water used for filling when raising steam should be as free from impurities as possible. This, together with frequent cleaning of the soot from the external surface, will help to maintain a constant superheat temperature.

Right Out of the Plant

Use of Rubber for Centrifugal Pump Bearings

IT HAS been my experience that one of the most troublesome parts to keep in shape about a plant is the main bearing of an overhung centrifugal pump. This bearing, being next to the rotor, is a hard one to keep lubricated, and unless it is properly lubricated both the shaft and the bearing tend to wear rapidly, causing the pump to become noisy and the packing to last but a short time. The stress of a fast-running impeller thrown out



Centrifugal pump fitted with rubber bearings

of balance by a worn bearing is frequently great enough to snap off the shaft at the shoulder. These troubles are more likely to occur in the smaller units than in the big ones, but the pumps are all vital to a plant's operation, whether located in the power plant or scattered as service pumps in other buildings.

Unless these pumps are made with a step-down shaft, which is the exception, any cutting from lubrication failure necessitates a new shaft as well as a new bearing.

In order to keep replacement costs within reasonable limits we have followed the practice of cutting off new shafts longer by the length through the impeller hub, wherever possible. With a babbitted outboard bearing this end rarely suffered seriously and the shaft could be turned end for end. This was always possible on belt-driven pumps and sometimes on motor-driven units. This practice saved the price of a shaft and some machine work. Also, the impeller hubs were deeply rounded so that a sharp corner was avoided on the shaft.

A development that promises considerable relief from this bearing trouble is found in the use of rubber as a bearing material. It is especially applicable where pumps handle water having grit in it. Rubber bearings are now stocked by supply houses in standard shaft sizes. They are made with a metal sleeve interchangeable with other sleeve bearings. The interior of these bearings is spiraled with lubricating grooves so that the rubber makes only about 50 per cent contact with the shaft. Water circulation through these grooves is the one means of lubrication.

When wet, rubber has a low coefficient of friction, which makes it an ideal bearing material from that point of view. The secret of success in its use consists of never operating without water, even at starting. A rough or pitted shaft also spells short life for the rubber, although the fact that rubber does not cut the shaft reduces this possibility to the use of right materials and workmanship in the first place.

In contrast to the two weaknesses mentioned, it should be known that a rubber bearing will carry a much higher load than would be suspected, owing to its comparative non-compressibility. And the speeds at which centrifugal pumps operate present no problem at all, since rubber's anti-friction qualities show up best at high surface speeds. These qualities indicate that rubber may well be considered for plant centrifugals, deep-well pumps, flood service, and so forth.

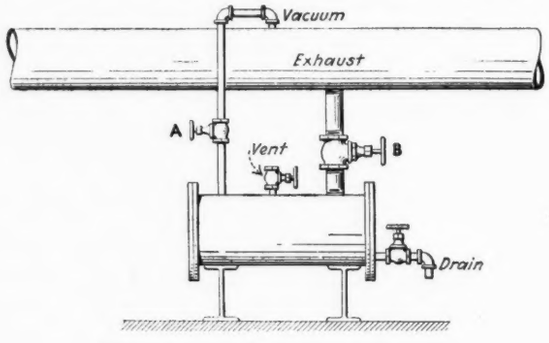
D. A. HAMPSON.

Middletown, N. Y.

Flooding a Barometric Condenser

I NOTED with interest the answer in the Readers' Problems page of *Power* of Jan. 1, to the question of whether a barometric condenser would flood an engine. I agree that it is possible under certain conditions to pick up water from the hotwell.

My experience, however, indicates that there is a greater danger of flooding the cylinder with water accumulated in the horizontal portion of the exhaust pipe rather than with water from the hotwell. The exhaust



How the receiver was connected

pipe is usually run some distance under the floor, and often a feed-water heater is added below the condenser. If the engine is operating under full load, very little condensation will stay in the pipe, for the stream, having a high velocity, will entrain the water and carry it over to the condenser.

But if the load is light a smaller volume of steam is passing, and as a greater condensation is taking place in the cylinder and piping, water will accumulate in the exhaust line. There is no danger from this water until the engine is stopped or the load is lost, whereupon the water in the pipe, part of which has been held in the vertical connection to the condenser head, will flow back and may damage the piston or, possibly, knock out a cylinder head. I have known a 26x52x48-in. cross-compound Corliss engine to have its low-pressure piston wrecked from this.

Unfortunately, there is not a steam trap made that will take this condensate from the pipe; in fact, the condensate will not run out, even if the engine is shut

down, unless air is admitted. However, it may be controlled by making a receiver out of a piece of large pipe with the ends sealed and placing this receiver under the exhaust pipe, connected as shown in the sketch.

The top of the exhaust pipe is connected by a small pipe and valve to the top of the receiver, which also has a drain and vent. If the valves *A* and *B* are opened and the drain and vent valves closed, the condensate will gravitate to the receiver; by reversing this operation the water may be drained from the latter.

The device may be made to operate automatically by connecting it to a small motor-driven centrifugal pump designed to work under a vacuum.

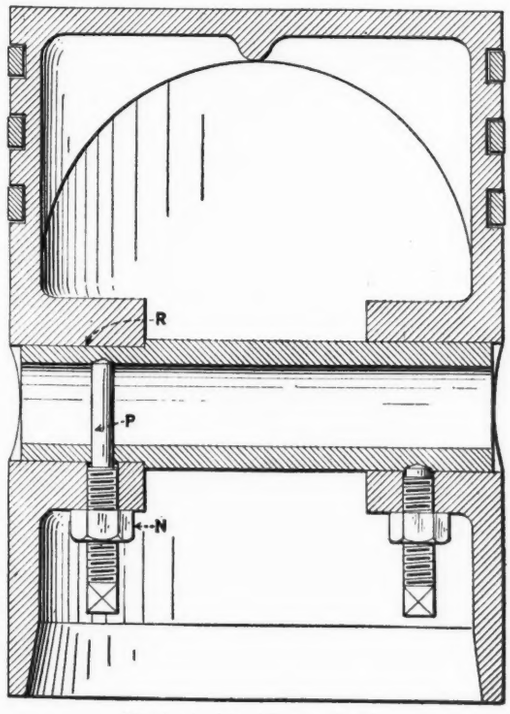
Mechanicsville, N. Y. GEORGE W. CLARKE.

Notes on Building Internal-Combustion Engines

RECENTLY, I modified the method of holding the wristpin of a stationary internal-combustion engine as shown in the illustration.

A hole is drilled through the wall of the recessed part *R* of the hollow wristpin and extended partly into the opposite side. After the pin is driven home, the long pin *P* is inserted and screwed firmly down into the bottom hole. Then the nut *N* is tightened, in order to prevent the pin from working loose. Owing to its length, the chance of its working loose is remote.

At the opposite side the wristpin is held by the usual



Method of locking wristpin

type of setscrew and provided with a small key fitting into a keyway machined in the bore of the piston body, so that it is easy to place the wristpin in position.

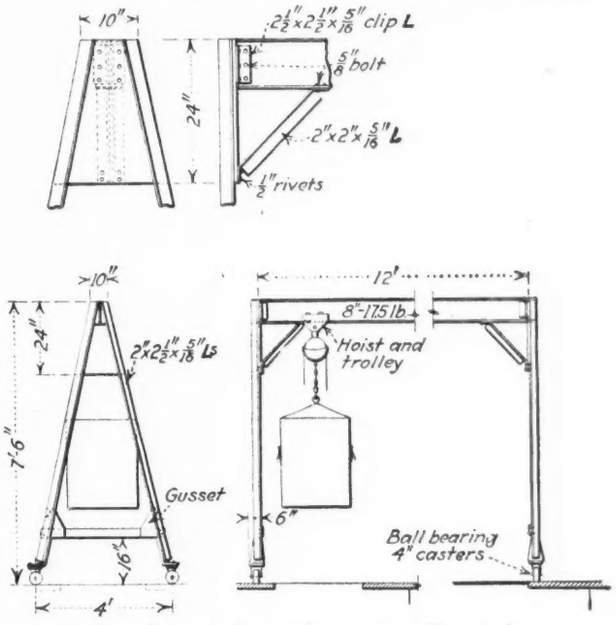
The piston rings of these engines are not finished to a glaze, but left somewhat rough, much like the cutting edge of an extremely fine hacksaw. During the trial on the test floor these projections wear rapidly to the contour of the cylinder liner, thus insuring a gas-light joint.

Epe, Holland. H. WIELAND LOS.

Portable Overhead Trolley Hoist Built to Suit the Job

THERE are many hoisting and transporting operations about a plant for which there is no apparatus on the market to suit the exact requirements.

It became necessary in one of our plants to provide means for hoisting and conveying some material over



Details and dimensions of trolley hoist

short distances. The stationary type of hoist, the overhead trolley and the various portable cranes available were for many reasons unsuited to our needs.

The accompanying illustration shows an overhead portable hoist built especially for the job in our shops and now in satisfactory operation. F. C. HOLBROOK.

New York City.

Auxiliary Screen in Water Box of Surface Condenser

FOR the last few months mussel shells, seaweed, and fish have been plugging the tubes in our surface condensers. These obstructions collect on the tube sheet or lodge in the tubes, and consequently reduce the amount of circulating water passing through the condenser. This necessitates frequent removal of the condenser head and cleaning of the tubes.

Upon investigation it was found that a part of the concrete circulating water tunnel had broken away at a point where the intake screens were set, thus permitting the shells, etc., to pass by. It was impossible to determine the extent of the break or to repair it owing to load conditions at the time. The only indication of the break was the concrete and rock found in the water box of the condensers and the sudden increase in the amount of material passing by the intake screens. The following temporary remedy was suggested, and perhaps it will be of value to other plant operators.

A flat screen should be made to install in the inlet water box of the condenser. This should be of sufficient size to cover all the tube ends and be placed in front of and in a plane parallel to that of the tube sheet. The

frame for the screen may be made of galvanized angle iron fastened with brass bolts or rivets and should have some perpendicular and horizontal braces to support the screen. For covering the frame any galvanized meshed wire screen may be used. The mesh size must be less than the diameter of the condenser tube so that anything passing through the screen will pass through the tubes.

A trough or basket made of the screen wire might be attached to the bottom of the screen and similar baskets placed above this, the number depending on the size of the condenser. When the condenser is drained, any loose material on the screen will drop and be caught in these baskets. With the completed screen in place in the condenser, the unit may be shut down, the condenser drained, manhole covers removed and the screen and baskets cleaned easily when it becomes necessary. The time required for this operation is short compared to that required to remove the condenser head and blow the tubes.

Norwich, Conn. EDWIN M. GAY.

Device for Determining Depth of Irregular Coal Pile

IN MANY plants it is usual practice once a month to estimate the amount of coal in storage by determining the number of cubic feet in the pile and converting this to tons. There are several ways of determining the various dimensions of a pile, but we have used a simple little device for measuring the depth. A hot-water bottle, a length of small rubber hose and a sensitive low-pressure gage are all that is required. The gage should be recalibrated to read in feet by holding the bottle at different known heights above the gage. Care should be taken that the water bottle, hose and gage connection are free from air, as this will give a false reading.

Two men are required in determining the depth of the pile. One holds the gage on the ground and takes the readings, and the other lays the bottle at regular inter-

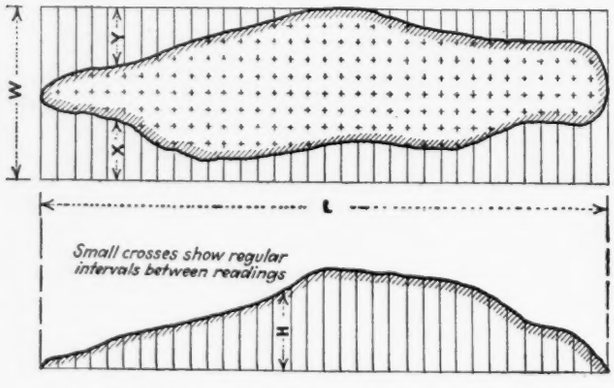


Fig. 1—Dimension chart of coal pile

vals over the entire pile. A good way to insure the proper spacing of readings is to have a cord with knots tied every six or eight feet. The gage man holds the end of the cord, while the bottle man, holding the cord, lays the bottle down at each knot and calls for a reading. When all readings have been taken, they are averaged, which gives the average height or depth H of the coal pile.

With the aid of a transit or any other means, a rectangle is made about the pile. The length L of the pile is the length of the rectangle. Then measure from each side of the rectangle to the edge of the pile at regular intervals throughout the entire length. When these are completed they are each averaged, thus giving X and Y. Subtract the sum of X and Y from the width of the rectangle W, the difference being the average width of the pile.

Then $L(w - x - y)H =$ volume of the pile. The weight of a cubic foot of coal varies, depending on the kind of coal, size of the lumps, etc. The most accurate

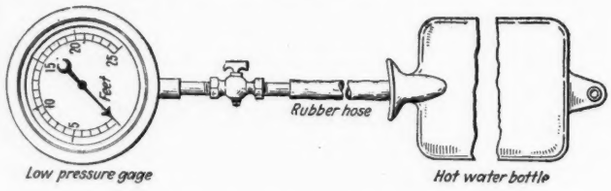


Fig. 2—Device for measuring the dept

way of determining this value is to take a container that holds a cubic foot and make a few tests to determine the weight per cubic foot of the coal in question. Multiply this value by the number of cubic feet in the pile and reduce it to tons. H. ALLEMANG.

Mishawaka, Ind.

Troubles in Steam Turbines

A CAUSE of corrosion and oxidation in steam turbines is defective steam stop valves. These must be kept tight, and the slightest leak must not be permitted when the valve is shut; otherwise the leaking steam will condense in the turbine and finally lead to corrosion.

Allowing the turbine to remain idle in direct connection with the moist condenser may also lead to corrosion due to the rising of moist vapors from the condenser. It should therefore be isolated from the turbine by a suitable stop valve when the latter is stopped. Another trouble is with the shaft packings. In some turbines this consists of carbon-packing rings held in position on the shafts by means of springs that rest in grooves in the carbon fittings.

A not infrequent trouble is caused by these springs losing their elasticity, cracking and breaking. When they have broken, the carbon fittings have frequently worked into the turbine and done damage. In one instance, where there was considerable trouble with springs fracturing, different kinds of springs were tried without success. It was noticed that where the springs were not in contact with the carbon, they seemed sound. A micrographic examination of some of the fractured surfaces seemed to show evidence of electrolytic action. Both the alternator and its exciter were known to be well insulated, but as circulating currents in the shaft may exist if the magnetic field is irregular, these were thought to cause the trouble. It was decided that the simplest remedy would be to insulate the springs from the carbon rings. This was done by dipping the springs in an insulating wash and painting the grooves in the carbon blocks with an insulating composition.

This remedied the trouble, and spring fractures ceased. The insulation naturally got chipped in time, but remained sufficiently intact to break electrical contact between the spring and the blocks. W. E. WARNER.

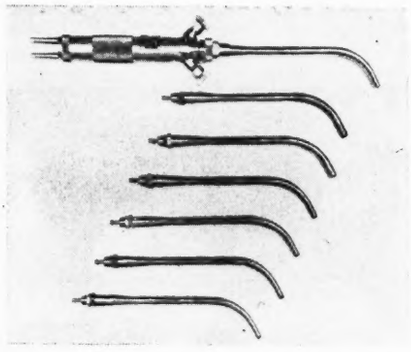
Brentford, England.

What's New in Plant Equipment

HOW THE MANUFACTURER CONTRIBUTES TO THE JOB OF GENERATING TRANSMITTING AND APPLYING THE POWER SERVICES

Blowpipe for Light Tubing and Sheet Metal

ALTHOUGH primarily designed for aircraft use, this Type W-15 blowpipe is also well adapted to work of all kinds on light tubing or sheet metal. It is of the injector type and



Blowpipe With Welding Heads

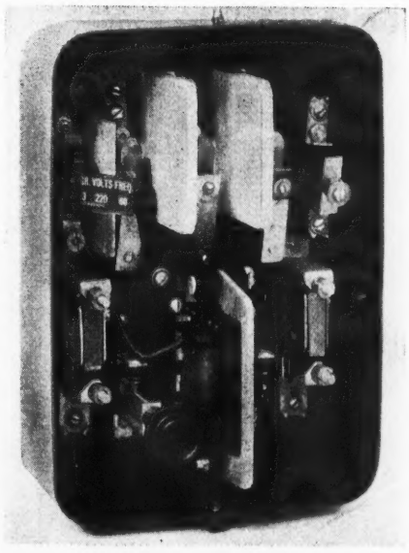
can be used on a low-pressure acetylene supply.

Welding heads, supplied with the blowpipe, seven in number, are equipped with drawn copper tips to withstand high temperatures and are curved to facilitate reaching inaccessible places. Each welding head is detachable as a unit, and each injector can also be detached from the welding head and replaced if necessary. The welding head is connected to the body of the blowpipe with a double conical seat and is held in place with a knurled nut. This nut is designed to be tightened by hand, but is also provided with faces so that a wrench can be used for loosening it if necessary. The usual screwed hose connections have been dispensed with and the $\frac{3}{16}$-in. oxygen and acetylene hose are connected directly to the blowpipe. Valves for adjustment of oxygen and acetylene pressure are placed on the handle in such a position that they can be operated by the thumb and forefinger of the hand holding the blowpipe, leaving the other hand free.

The various welding heads are all designed for a constant oxygen pressure of 20 lb. per sq.in., making it possible for the welder to change the heads without changing the adjustment of the oxygen regulator. The blowpipe was recently introduced by Oxweld Acetylene Company, 30 East 42nd St., New York City.

Magnetic Switches Simplify Installation

THE General Electric Company announces two new switches in its line of general-purpose starters for small alternating-current motors. One is a three- or a four-pole magnetic



Three-pole switch with cover removed

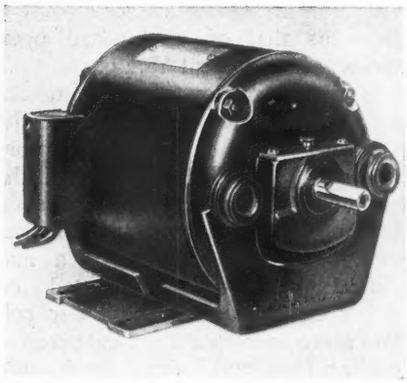
switch with self-contained "start" and "stop" stations, and the other, a switch for similar service but designed to provide large wiring space.

The first mentioned, shown in the figure, is of standard design, incorporating features for overload and undervoltage protection or release, and is used for starting and protecting small alternating-current motors that can be thrown directly on the line. It consists of a triple-pole barrier-type contactor and a double-coil temperature overload relay, all mounted on a molded base in a drawn-shell steel inclosing case. Added to these are starting and stopping contacts ordinarily provided by a remote-control push-button station. This switch is used in installations where it is desired to place the control at the driven machines, making remote push-button control unnecessary.

Although the other type of switch is for the same general class of applications as the first, it is designed for use with remote push-button stations. Its principal advantage is the large amount of wiring space provided. The switch mechanism is placed below the center of the box to prevent interference with the mounting holes. This construction also allows plenty of room for the arc, thus preventing flashovers.

Rubber-Mounted Motor

IN THE new rubber-mounted motor recently announced by the Wagner Electric Corporation, of St. Louis, Mo., the motor proper is completely insulated from the supporting cradle-shaped base, by means of rubber bushings. The design of the mounting is such that the vibration is reduced to a minimum, the outfit



Wagner type 57 RA rubber-mounted

is practically rigid and shaft alignment is in no way endangered. Also, the new style mounting has been effected without a change in over-all length and width dimensions.

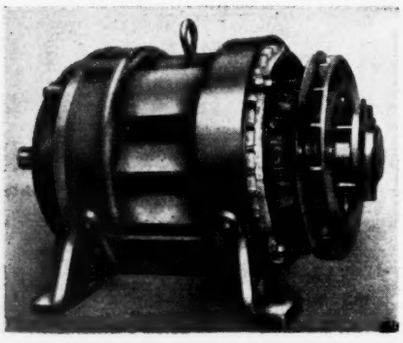
In addition to the mounting the motor has also undergone important alterations to improve further its quietness and electrical performance. In addition to equipping the governor weights with rubber bumpers, as was done previously, the rocker arm has

been redesigned to eliminate brush noise during starting and stopping. The power factor and efficiency have also been improved.

The motor is of the brush-lifting type, the brushes being lifted off the commutator as soon as the rotor attains operating speed. This feature insures quietness in operation and tends to prolong the life of commutator and brushes.

Totally Inclosed, Fan-Cooled Squirrel-Cage Motor

AN IMPORTANT feature of the line of totally inclosed motors recently brought out by the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., is that their size is approximately the same as that of a standard open motor of equivalent rating.



Westinghouse type CS motor

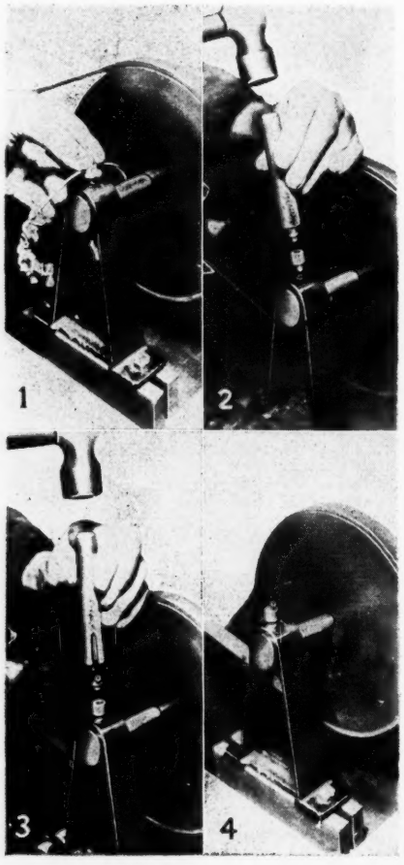
The construction of these motors is almost identical to that of the standard open motor. The stators differ only in that the ends of the windings are inclosed in sheet-metal housings. The rotors are identical except for the addition of a machined steel collar mounted on either end of the shaft. These collars serve as supports for the external cooling fans, which draw air through the brackets at either end, direct it over the entire outside surface of the protective housing and discharge it through the middle section. This construction makes possible the use of short direct air passages. The clean air sealed in the interior of the motor is kept in circulation by the fans on the ends of the rotor.

These motors use the same control as any standard squirrel-cage induction motor and may be started at reduced voltage by the "Auto-starter," or across full-line voltage by the "Line-starter."

Threadless Oil-Hole Lubrication Fittings

WITH a view to simplifying the installation of standard high-pressure lubrication fittings on the regular open-hole-type of bearing the Alemite Manufacturing Company, Chicago, Ill., recently brought out a line of fittings that are simply driven into place in the bearing, as shown in the illustration.

A reverse feather-edged bushing of the correct size is first driven into the open oil hole with a hammer and special driving tool, as shown in Fig. 2, no special drilling or threading being necessary. The bushings are made in sizes from $\frac{1}{8}$ to $\frac{1}{2}$ in., varying by sixty-fourths. Special bushings are made for countersunk holes and for thin housings. Into the top of the bushing a nipple with dirt-proof ball check is installed, as shown in Fig. 3.



How the fittings are installed

An ordinary hammer and a set of three special drive tools form the complete equipment for installing these fittings. Fig. 1 shows how the correct size of bushing is obtained, and Fig. 4 shows the finished job.

Indicating and Recording Diaphragm Meter

THE type GK diaphragm meter illustrated operates by direct mechanical connection to a diaphragm that is moved by fluid pressure transmitted from an orifice in the main pipe line. Fig. 1 is a general view of the meter, and Fig. 2 is a diagrammatic section through the diaphragm case of the instrument and its connections to each side of the orifice in the pipe line.

The movement of the diaphragm, in response to the change in pressures at the orifice in the pipe line, is transmitted through a crank and shaft to an indicator hand. The movement is restrained by two bronze springs, provision being made for changing the tension of one spring from the outside to provide a zero adjustment for the indicator hand. The diaphragm case is of bronze and is outside of and separate from the instrument case.

Fig. 1—Type GK diaphragm meter

An indicator dial, graduated from 0 to 100 units, shows the rate of flow. It is fourteen inches in length and has large white figures on a black background, making it easily read from a considerable distance. The recording chart is eight inches in diameter and, like the dial, is decimally graduated so that the readings are directly in percentage of maximum and are multiplied by a constant to obtain actual quantities. The chart is driven by a telechron electric clock motor.

A register, or counter, of the straight reading type, is in the lower part of the case. It is operated by a ratchet and pawl driven from the chart motor, the pawl moving the

ratchet a varying amount depending on the rate of flow.

The meter which is put out by Builders Iron Foundry, Providence, R. I., is designed to mount on a wall bracket, the over-all dimensions

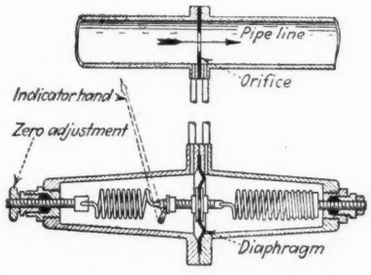


Fig. 2—Diagrammatic section through diaphragm case of meter

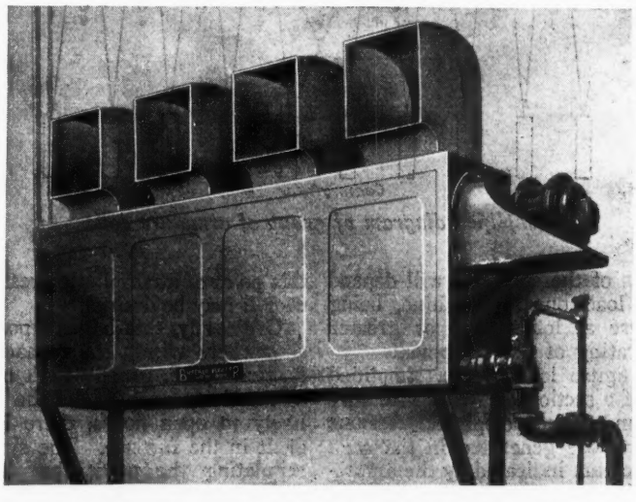
being 18x24 in. It can be placed in any convenient location above or below the pipe line and at any distance up to 100 ft. from the orifice.

Industrial Unit Heaters in Two Types

TWO unit industrial heaters, designated as "Lowboy" and "Highboy," have been introduced by the Buffalo Forge Company, Buffalo, N. Y. The units are similar in design except that the "Highboy" has two sections of heating elements instead of one, as in the "Lowboy" illustrated. Each type can be installed vertically, horizontally or inverted, and each is suitable for flooring mounting, wall bracket mounting or for ceiling suspension.

Four units are used in the heater, each unit having its own fan housing. The multi-fan rotors are of the centrifugal type and are all mounted on one shaft with a ball bearing on each end. A flexible coupling is furnished for direct connection to a motor. The heating elements are built up of "Aerofin" tubing suitable for pressures from 2½ to 150 lb. The heater elements can be removed through the end plate at either end of the unit.

The motor bracket end plate and the outboard end plate are interchangeable so that the drive can be placed on either end. The motor bracket can be revolved to any position of discharge. The heater can be assembled with steam or drip connections on either end as desired. When mounted upright, the "Highboy" has an over-all height of 90 in. and the width is variable from 61 to 100 in., for the three sizes manufactured. The "Lowboy" has a height of 60 in. over-all, the other dimensions being the same.



The "Lowboy" unit installed with wall brackets

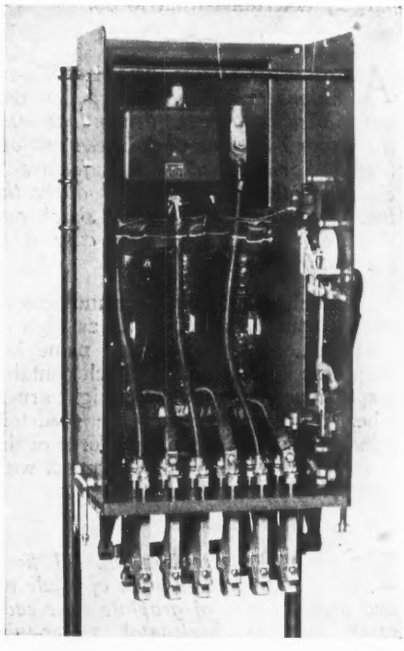
Welding Gloves of Suede Leather

GAUNTLET gloves of a soft and pliable suede leather, specially treated to prevent their stiffening or shriveling from the application of heat or from soaking in water has been added to the line of accessories for oxyacetylene welding and cutting, put out by the Oxweld Acetylene Company, 30 E. 42d St., New York City.

A leather strip on the thumb seam and a semicircular reinforcement on the inside seam adjoining the palm reinforce the glove. The left glove has a leather reinforcement, covering the entire back between the fingers and gauntlet, for protecting the back of the left hand during cutting operations. A close-fitting gauntlet protects the arms.

Compensator Has High Interrupting Capacity

HIGH interrupting capacity is a feature of the manual starting compensator illustrated, recently brought out by the General Electric Company, Schenectady, N. Y. The new compensator is especially applicable to the control of high-speed squirrel-cage motors, including all two- and most four-pole motors, particularly those driving loads of relatively high inertia and therefore taking high inrush currents and requiring considerable time to get up to speed.



Manual starting compensator with cover and oil tank removed

Among the advantageous features claimed for the new compensator by the manufacturer are the following: A switch design providing wide break and high interrupting capacity; time-delay undervoltage release, preventing shutdown on brief power disturbances and assuring that in case of short circuit the line protective devices will open first; contact tips of standard contactor construction and action; cabinet construction of case for wall mounting, with ample room for ready connections and access to all parts.

FROM AMONG THE READERS'

Conducted
By
L. H. Morrison

PUMPING WATER THROUGH A HIGH SUCTION LIFT.—*How would you make a pump work that was placed 30 ft. above its supply?* G. G. W.

In the first place, make the suction line as large as possible, and in the second place, a vacuum pump could be put on the suction line so that this pump could remove all the air as fast as it was released from the water; water usually carries considerable air, and the amount released increases with the decrease in pressure. If the vacuum pump is used, the suction pipe will not have its vacuum partly destroyed by the pressure of this air. This answer may not cover the specific installation, as local conditions largely determine what to do.

AUTOMATIC CLUTCH PULLEY.—*We are anxious to obtain a clutch that will automatically apply the driven load after the motor has come up to speed without load. Someone must manufacture a clutch of the type that will apply the load gradually and without shock and disengage the load in case current to the motor is shut off.* C.D.R.

A clutch of this type is manufactured in this country in capacities as high as 1,000 hp., and the builder's name has been sent by mail. The clutch contains a split inner ring and two weight arms; when the speed reaches the predetermined value, the centrifugal force of the arms expands the ring into contact with the driven part of the clutch.

FEEDING OIL TO BOILERS.—*I have been feeding three pints of crude oil and one-half pint of graphite once each week to two horizontal water-tube boilers, opening the blowoff valve once each day. This practice has been followed every winter for the last twelve years. The boilers are insured and are inspected internally once each year by the inspector. I have been complimented by almost all of the inspectors for having such clean boilers, and each one of them has approved the use of the crude oil and graphite until the last inspector, who does not approve it at all. The last two winters we have been running low pressure, as the only duty the boilers have is to heat our courthouse. Our water supply comes from springs owned by the city water company and is run through a chemical purifier.* R.K.L.

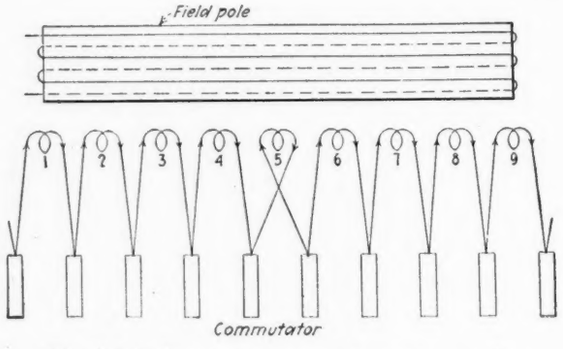
Although you state that you have been adding graphite and oil to the boilers for the last twelve years, this is not considered a good practice. The amount you add is considerable, and there is danger of this oil settling on the bottoms of some of the lower tubes and causing blisters. A far better method would be to clean the drum and tubes of your boilers thoroughly and then swab them with graphite paint. This would cut down the corrosion if you are being bothered with this trouble.

Of course the service conditions would largely determine whether an inspector should or should not permit you to use the crude oil. If you are forcing these boilers, the inspector was not using undue caution in recommending the discontinuance of the oil treatment.

EFFECT OF REVERSED COIL IN ARMATURE WINDING.—*Will a coil connected reverse in an armature winding cause this coil to burn out? I have heard considerable argument on this question and would like to know what really takes place.* C. M. R.

Connecting a coil in reverse in an armature winding will not cause the coil to overheat and burn out, but will probably cause sparking at the brushes. The seriousness of the sparking will depend upon the load on the machine, being most severe at loads near or greater than the rating of the equipment.

In the figure is shown a simplified diagram of a section of a ring armature winding under one polepiece. Assume that the voltage generated in the coils is in a direction indicated by the arrowheads. Tracing through the coil will show that the voltage in coil No. 5, which has its leads reversed to the commutator, opposes the voltage generated in the other coils. This causes two effects. The resultant voltage of this coil group is reduced below that of other coil groups in the winding. Also, the voltage in the reverse connected coil will be in a direction to prevent the current reversing in the coil as its leads pass a brush on the commutator. The latter effect is what causes sparking at the brushes.



Simplified diagram of group of armature coils

The voltage, being unequal in the groups of coils under the poles, will tend to cause circulating currents to flow in the armature winding. These currents will heat the whole winding, reduce the efficiency of the machine and may cause sparking at the brushes.

MEANING OF BALANCED DRAFT.—*What is meant by balanced draft, negative draft, and what is the usual draft above the fire?* R.A.B.

In a natural draft installation the pressures throughout the setting are lower than atmospheric, from the ashpit to the top of the stack. In a forced draft installation without any stack, the pressures throughout the system are above atmospheric, from the discharge of the fan to the exit of the gases.

In a combination of forced and induced draft the pressure at the forced-draft fan discharge is above atmospheric, and the pressure at the bottom of the stack, or at the suction of the induced-draft fan, is below atmospheric. Somewhere in the setting atmospheric pressure prevails. By the adjustment of the fans and dampers it is possible to locate this point of atmospheric pressure wherever it may be desired.

Ordinarily, this balance point is kept somewhere within the furnace or combustion space, usually high up, so that at the floor level, where the fireman is likely to open doors, there is a slight draft in the furnace. The system of so regulating the outfit that there is a slight draft over the fire, has been known as "balanced draft." It is customary to carry a draft over the fire of a few hundredths of an inch of water. The object is twofold—first, to insure the safety of the operators who may open doors, by preventing hot gas being driven out into the room, and second, to increase the life of the firebrick wall by setting up a constant but slight infiltration of air through the porous brickwork, thereby keeping it somewhat cooler than it would be if hot gas were driven outward.

PROBLEMS

ANSWERS

from Our Readers

THE QUESTION

SINCE high-pressure steam in a soot blower may cause tube cutting, at what pressure is one justified in installing a reducing valve?

P. Q. R.

SOOT-BLOWING elements are generally equipped with nozzles designed especially for the pressure with which they are to be used. However, in cases where the pressure is about 400 lb. it would appear to be good engineering practice to install a reducing valve to bring the pressure below this point. The advantage of the lower pressure is that it materially reduces the duty on the stuffing box of the operating head and also reduces the erosive action on the valve disk and seat when the valve is opening and closing.

However, blowers are even now being operated with steam at 800 lb., and even higher pressures are being used in an experimental way. C. G. JONES.

Buffalo, N. Y.

MY opinion is that a high pressure is required to blow soot from tubes. Just what the pressure should be depends on the style of boiler and the length of time that has expired since cleaning.

If heavy soot appears it should require not less than 100 lb. steam pressure. There is no danger of cutting tubes unless the tube blower is held in one place for an extremely long time. This is something that hardly ever occurs, as most all boiler-room workers generally hurry this job. But should there be danger of cutting tubes by a higher steam pressure, a muffler screwed over the end of the nozzle would eliminate all the risk of tube cutting.

I cannot see any danger of tube cutting from any sort of steam pressure if the operator handles the blower right.

My opinion is that any boiler that can be cut by a soot blower properly used is a dangerous article in a boiler room under any pressure. E. F. STRIPPY.

Mt. Rainer, Md.

I THINK this question is a little out of the ordinary in that when blowers are used for removing soot from the outside of tubes, all orifies are so arranged that no direct steam flow will strike a tube.

The company that manufactures the soot blower determines the size of the nozzles, making them large or small, according to the steam pressure carried on the boiler. The valve that controls the rotating tube containing the orifice is set to allow only a certain flow of steam necessary to accomplish the cleaning. So a reducing valve is unnecessary.

On fire-tube boilers orifices are set directly in line with the axis of the tube and no steam strikes the metal of the tube. The main control valve should be set to admit just sufficient steam to accomplish the cleaning. A reducing valve is not justified in this case.

In my experience the cutting of tubes is caused either by improperly aligned orifices or by a too long duration of blowing. C. D. DONOVAN.

Elephant Butte, N. M.

THE writer who asks the question apparently is not intimately acquainted with soot blower design.

Soot blowers for water-tube boilers have the nozzles so placed that the center of the steam jet does not impinge upon the tube until its velocity has been largely lost. There is, then little likelihood of tube cutting.

The idea of using a reducing valve or any pressure reducing agent is to avoid the excessive loss of steam. Steam flow through an orifice can be found by Napier's formula, $W = \frac{AP}{70}$, when A is the nozzle area and P is the header pressure. With a given orifice the steam used by the blower varies directly with the header pressure. If this be made one-half the steam pressure by a proper control, the steam so used is reduced by one-half. Steam at 150 lb. will give sufficient velocity to blow off the soot.

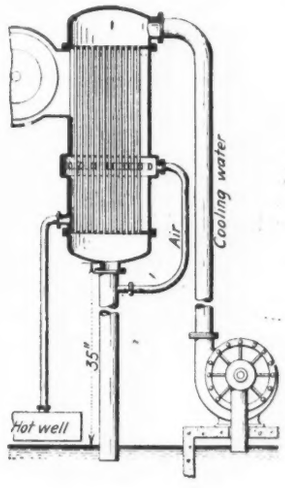
It is usual to use the full boiler pressure up to about 200 lb., and for higher boiler pressures an orifice plate is placed in the line to the revolving blower head. This orifice is of a diameter sufficient to reduce the header pressure to about 150 pounds.

In blowing soot from a fire-tube boiler, the fireman usually pinches down on the globe valve at the end of the steam hose, until the pressure is high enough to remove the soot, but not so high as to cause the steam to blow back.

New York City. GEORGE GROW.

IF THE reader asking the question intended, by the term "reducing valve," to include all means of reducing pressure, I should say that with a boiler pressure of above 300 lb. a reducing valve should be used. However, in place of an actual valve it is usual to install the simple and cheaper orifice plate. The plate has an orifice such that the pressure in the blower head is reduced to about 150 pounds. B.B.C.

Jacksonville, Fla.



A Question For Our Readers

IS THE barometric-type surface condenser feasible? If not, why? It is proposed to place the condenser and turbine at such an elevation that the pressure in the tubes is slightly less than the condenser shell vacuum. This would prevent a leakage. Condenser, and the barometric pipe would be as shown in the illustration.

G. W. C.

Suitable answers from readers will be paid for and published in the March 12 issue

The Present Status of WELDING IN POWER PLANTS

The power service applications of welding are increasing rapidly, both in the variety and quantity of work done. This summary, slightly abridged from a recent report of the Oxyacetylene Committee of the International Acetylene Association, gives a fairly comprehensive view of the present situation, although a complete picture is clearly unattainable.

THE use of oxyacetylene welding in power plants for both construction and maintenance is so general that we no longer try to evaluate such equipment any more than we would try to determine the value or necessity of a machine shop. It is essential equipment and our only concern is in increasing our skill and scope in its application.

In construction it has been used especially in sheet-metal work. Such material is now largely cut and fabricated in the field, with great savings by (1) eliminating very detailed drafting layouts to determine exact clearances, (2) eliminating the ordering, handling and storage of special pieces cut in a mill, (3) reducing the necessity for flange-and-bolt assembly.

In construction work it has an indispensable use in the fitting of metal parts that are not quite true to dimension and that would otherwise need to be returned to the mill. As many as twelve welding units have been in use at one time in the construction of one station. Gas welding has been used in assembling a 20-in. steam-heating main where flanges and bolts have been eliminated entirely except at expansion joints. At 200 lb. pressure this 4,000-ft. line has given no trouble in four years of intermittent operation.

In maintenance work the use of the welding process is broadening daily. Three units are used continuously at one station. It has been used in the past for the infinite number of repairs made on the equipment in place. A more recent use has been in the elimination of machine work on repair parts. For example, the wear rings in coal-pulverizing mills were formerly machined to fit in place. It has been found to be perfectly feasible to fit these rings with a torch.

Another interesting use was recently worked out in several central stations where an oxyacetylene torch is used in pulverized coal and oil burning furnaces for igniting the fuel on starting up the boiler.

One of the important uses of the gas torch is the salvaging of shafting from auxiliaries of a wide variety. Worn or eroded shafting from pumps, motors, turbines, cars and the like can be built up where necessary and turned to the required size with a saving of material and machine work. Where new shafting is occasionally required, smaller shafting can be used by building up where shoulders are required rather than starting with the larger shafting and turning down at each step.

One rather recent application of gas welding outfits is the coating of auxiliary parts, such as pulverized mill paddles, with Stellite to give greater hardness and increase the life of the parts. By this means cast-iron parts may be utilized in many places requiring, ordinarily, more expensive steels, with substantial savings.

For the purposes of a survey of welding applications the power services should be considered as a unit, since their construction, operation and maintenance are supervised by the power engineer or plant engineer rather than by the production man. The power engineer's job is the generation, transmission and application of the power services: steam, hot water, cold water, compressed air, fire service, electricity, mechanical power, heating, ventilation, air conditioning, centralized lubrication, refrigeration, industrial oil and gas, etc. This involves not only the equipment in the power house proper, but a maze of piping, ducts, conduits, shafting, heaters, motors, pumps, fans, tanks, coils, gears, speed reducers, etc., in the works outside of the power house. All this is included in the larger use of the term "power plant."

The field, for the purpose of this study, is therefore broken down into the following units:

GENERATION ONLY

Steam-electric power station
Hydro-electric power station
Diesel-electric power station

GENERATION, TRANSMISSION AND APPLICATION

Refrigeration
Steam services (for process and heating)
Compressed-air service
Hot-water service
Other pumping services
Blower and exhauster services
Electrical services
Mechanical power services
Heating, ventilation and air conditioning

In each of these fields there are listed the principal uses of welding. The list is based on general observation only. The uses are marked as follows:

**Widely used and likely to supplant other methods.

*Considerably used.

(No mark) Used to some extent.

1—Steam-electric Power Stations (utility and industrial)
- A—Construction
  - Air-tight steel castings for boiler settings*
  - Breechings**
  - Stacks*
  - Air heaters*
  - Air and gas ducts (boiler room, turbine room)**
  - General sheet-metal work**
  - Steam piping**
  - Water piping**
  - Exhaust piping**
  - Condenser circulating water piping**
  - Soot-blower manifolds*
  - Oil lines**
  - Compressed-air lines**
  - Pulverized coal and dry ash collectors**
  - Ash hoppers*
  - Water tanks**
  - Closed feed-water heaters*
  - Hotwells for extraction heaters**
  - Condensers (future use)
  - Brackets and supports for instruments and controls*
  - Bases for motors, fans, pumps turbines, etc.
  - Motors
  - Fans*
  - Coal and ash conveyors
  - Coal larries
- B—Repair and Maintenance
  - All parts listed under Construction
  - Boilers (within limitations imposed by Boiler Code)
  - Stoker parts**
  - Pistons**
  - Cylinders**
  - Cast-iron frames**
  - Pumps**

2—Hydro-electric Stations
- A—Construction
  - Structural steel (mostly in future)
  - Penstocks*
  - Waterwheels
- B—Repair and Maintenance
  - Parts listed above

3—Diesel-electric Stations
- A—Construction
  - Oil storage tanks**
  - Oil lines**
  - Water lines**
  - Exhaust lines**
  - Mufflers*
  - Oil heaters*
- B—Repair and Maintenance
  - Parts listed above
  - Engines

4—Refrigeration
- A—Construction
  - Water lines**
  - Brine lines**
  - Ammonia lines**
  - Ammonia receivers**
  - Water tanks**
  - Ice cans**
  - Brine coolers*
  - Condensers*
- B—Repair and Maintenance
  - Parts listed above
  - Ammonia compressors*

5—Steam Services (these exist even where no power is generated)
- A—Construction
  - All boiler-room work listed under "Steam-electric Stations"
  - Steam receivers**
  - Steam lines**
  - Condensate return lines**
- B—Repair and Maintenance
  - Parts listed above

6—Compressed-Air Services
- A—Construction
  - Water lines**
  - Compressed-air lines**
  - Pressure tanks**
- B—Repair and Maintenance
  - Parts listed above
  - Air compressors

7—Hot-water Services
- A—Construction
  - Steam-fed water heaters**
  - Hot-water lines**
  - Heat-transfer apparatus**
- B—Repair and Maintenance
  - Parts listed above
  - Pumps*

8—Other Pumping Services
- A—Construction
  - Fluid lines**
  - Fluid heaters**
- B—Repair and Maintenance
  - Parts listed above
  - Pumps*

9—Blower and Exhauster Services
- A—Construction
  - Fans*
  - Ducts**
- B—Repair and Maintenance
  - Parts listed above

10—Electrical Services
- A—Construction
  - Foundations for generators, motors and rotaries
  - Supports for transformers*
  - Motors*
- B—Repair and Maintenance
  - Parts listed above

11—Mechanical Power Services
- A—Construction
  - Supports for speed reducers*
  - Guards for pulleys, belts and gears**
- B—Repair and Maintenance
  - Parts listed above

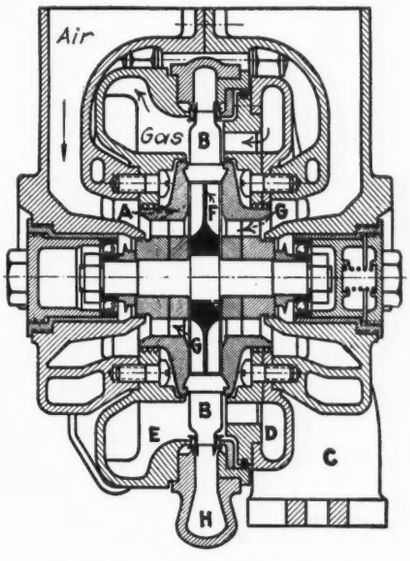
12—Heating, Ventilation and Air Conditioning
- A—Construction
  - Boiler-room work as listed under "Steam-electric Stations"
  - Welded low-pressure boilers*
  - Indirect heaters*
  - Unit heaters*
  - Fans*
  - Steam lines**
  - Hot-water lines**
  - Air ducts**
  - General sheet-metal work**
- B—Repair and Maintenance
  - Parts listed above

This list covers the outstanding uses that come to mind, but it is far from complete. The fact is that welding apparatus, and in particular the oxy-acetylene welding and cutting torch, has become an all-purpose tool with an almost infinite number of applications.

Probably the widest power-plant application at the present time is for piping, where welded lines reduce leaks, save time and layout work, eliminate expensive fittings and (in the case of hot water and steam lines) reduce insulation costs and heat radiation. Welding is definitely established in this field and its use is increasing rapidly.

The Lorenzen Gas Turbine

THE Lorenzen gas turbine, which was recently tested at the experimental station of the German Aëronautical Institute, is a distinct advance in the development of a practical and efficient turbine. The design, which is



Section through the Lorenzen gas turbine

described in *Zeitschrift Des Vereines Deutscher Ingenieure* of Dec. 22, 1928, embodies the use of hollow gas buckets through which a continuous stream of cooling air is forced in a radial direction by an internal fan wheel that turns with the gas rotor. This feature prevents excessive bucket temperatures, and part of the heat absorbed by the air is recovered by using the air for charging the gas engine. So far this type of turbine has been driven only by the exhaust from high-speed gasoline engines, but there are indications that it can be applied to large slow-speed engines.

Even with the defects that accompany an initial design, the turbine is capable of converting into useful work between 12 and 16 per cent of the energy delivered by the engine exhaust when operating between 10,000 and 25,000 r.p.m. The higher efficiency was obtained at the lower speed, a favorable condition which leads to the prediction that the efficiency of internal-combustion engine installations may be materially increased by the addition of a gas turbine.

The construction of the turbine is shown in the illustration. The rotor consists essentially of two steel disks *A*, between which the bases of the hollow turbine buckets *B* are securely wedged in annular grooves. The buckets are pressed from a special steel tubing into a crescent shape at the center, which changes to form a four-cornered section at the tips. The gases enter the turbine through the chamber *D* and are exhausted downward from the chamber *E*. The radial fan wheel *F* is keyed to the shaft between the rotor disks and directly in line with the base of the gas buckets.

The cooling air is drawn into the fan wheel through the passages *G* and is discharged radially through the hollow buckets into the diffuser chamber *H*. The four-cornered open bucket tips protrude into this chamber and are sealed by the labyrinth rings to prevent excessive leakage of the delivered air into the exhaust chamber. The turbine shaft runs in ball bearings and does not extend through the housing.

The over-all dimensions of the turbine approximate those of the usual supercharging blower, and the turbine may be substituted for the latter without making radical piping changes.

From the experience obtained in operating the turbine with exhaust gases, the designer has developed a true gas turbine of large capacity. This machine is in course of construction, but no details concerning it are as yet available.

The turbine using exhaust gases should not be confused with an internal-combustion gas turbine. The former can and is successful, for the driving fluid is a waste product and the power gained is net. The turbine in which a fuel charge is burned works against great odds. It must be charged with the work of compressing the air and fuel charge, and as the over-all compressor efficiency is not high, the net turbine efficiency is low.

CO_2 *Accelerates Corrosion In Steam Heating Systems*

IN MANY localities a considerable wastage of material in steam-heating systems results from corrosion; particularly is this noticeable in return lines. The importance of this wastage will be recognized when it is considered that about 40 per cent of all the piping (excepting electrical conduit) used in the construction of large buildings is for heating.

In the modern power plant of today corrosion has been eliminated to a large extent by chemical treatment and deaëration of the feed water. The need, however, of such treatment in steam-heating systems has only recently been recognized.

Corrosion is associated mainly with certain types of boiler feed water and, therefore, varies widely in different localities. It depends largely upon the composition and quantity of non-condensable gases evolved with the steam. Oxygen and carbon dioxide are the gases that influence corrosion to the greatest extent.

The most common source of carbon dioxide in steam-heating systems is from the bicarbonate hardness of the boiler makeup water. The bicarbonate, when heated in the boiler, is reduced to the carbonate and carbon-dioxide gas is set free. It may also be generated by the decomposition of soda ash, which is commonly added to the feed water to prevent the formation of hard scale on the boiler surfaces.

The mechanism of corrosion is now generally understood. Essentially, the reaction involves the solution of iron in water to form ferrous hydroxide which, in the presence of free oxygen, forms the more insoluble ferric hydroxide, commonly known as rust. During the reaction a proportional amount of hydrogen is formed, which polarizes the metal and quickly stops the solution of more iron. When oxygen is present, it unites with the active hydrogen to form water; or if an acid such as formed by carbon dioxide is present, molecular hydrogen is formed and evolved as a gas. In either case, when the restraining effect of the hydrogen film is removed, more iron enters solution, and these reactions are repeated until either the iron or the free oxygen is exhausted. Thus, the chemical factors controlling corrosion in steam systems are essentially oxygen and carbon dioxide, the latter being the chief accelerator.

One of the most effective methods of cutting down the rate of corrosion in return lines, due to the presence of carbon-dioxide air mixtures, consists in providing a complete gravity flow of condensate from all portions of the return system to the boiler plant. This prevents "dead ends" and allows a moderate vacuum to reduce greatly the carbon-dioxide content of the gases in the return main.

Adequate vacuum pump capacity keeps the carbon-dioxide content of the gases low owing to the sweep out that results from the unavoidable inleak of air. Reduction of steam losses reduces the proportion of makeup water and thus reduces the quantity of carbon dioxide that will be liberated in the system.

Adequate lime-soda treatment of the make-up water before it enters the boiler will decrease the carbon-dioxide content of the system to a great extent. In low-pressure steam boilers, where corrosion occurs in the return line, an excess of caustic soda with an equal amount of sodium sulphate will help matters considerably. In this case the hydroxyl alkalinity should be maintained at least twice the carbonate alkalinity in order to avoid caustic embrittlement.

The important part CO_2 plays in accelerating corrosion in steam and return line piping and methods of reducing its effect on heating systems are indicated in this article.

The installation of deaërator heaters will help to eliminate both the oxygen and carbon dioxide before the feed water enters the boiler. This has the advantage of tending to avoid corrosion in the boiler as well as in the pipe lines.

Recently, experiments were undertaken at the Engineering Experiment Station of Iowa State College, by Hayes, Henderson and Staneart, to determine the effect of carbon-dioxide air mixtures upon the rate of corrosion. In these experiments a sample of pipe was submerged in water and arranged so that a carbon-dioxide air mixture flowed in a steady stream over it. The results of these experiments are reported completely in Bulletin No. 84, of Iowa State College, and indicate that air free from carbon dioxide, when at a temperature of 190 deg., causes corrosion at the rate of 0.00435 grain of iron per day per square inch of surface. When, however, the iron sample was subjected to the action of an air mixture containing 4 per cent of carbon dioxide, the rate of corrosion was increased to about 0.0085 grain of iron per day per square inch. This is about double the corrosion rate when air alone is present.

Considering a portion of the return system in a steam-heating plant where the conditions of these experiments hold, it may be calculated from these data that in the presence of air alone a return main of standard 2-in. pipe would last sixteen years, assuming uniform corrosion. Where pipe ends are threaded, thus reducing the metal thicknesses, or where inclusions are present that cause local action, this figure will be greatly reduced, and a life as low as ten years, as estimated by the Bureau of Standards, might result. In the presence of a mixture of 4 per cent carbon dioxide and air, a similar calculation gives the maximum life as six years, which, with threaded ends, would be reduced to approximately four years. These estimates agreed well with the observed life of the mains where the conditions maintained in these experiments existed.

The carbon-dioxide content of the gases in return mains varies over wide limits, depending upon the more or less complete sealing of dead ends, the proportion of makeup water that must be supplied to replace unavoidable losses from the heating system, the treatment to which the makeup water has been subjected, and the quantity of air leaking into the vacuum system. As high as 16 per cent carbon dioxide has been found behind especially bad water seals, and values from this down to zero have been encountered in other portions of the same system.

In general, the problem of corrosion in heating systems increases with the size of the system and with the amount of raw water fed to the boiler.

Chromium Plating Piston Rods

ONE strikingly successful application of chromium plating has been on 9-in. piston rods of marine Diesel engines. These rods run in a cast-iron packing with only moderate lubrication. It was found that the application of 0.003 in. of chromium to the surface of the rods resulted in smoother operation and less difficulty in lubrication.

The unplated rods lost about 0.001 in. in diameter for every 5,000 miles of service, while the chromium-plated rods required 54,000 miles of operation to produce this same loss in diameter. Incidentally, these pison rods, which were water-cooled, were also plated on the inside with chromium, which greatly reduced the corrosion.—*Excerpt from paper by W. Blum, before the A.S.M.E.*

Events and Men in Power's Field

THE EDITORS WILL WELCOME THE CO-OPERATION OF READERS IN REPORTING INTERESTING HAPPENINGS, PERSONAL OR OTHERWISE

High Pressure an Economic Success A.S.M.E. Speakers Agree

Moultrop and Brown Bring History of Edgar Station Up to Date and Predict Substantial Savings from General Adoption of High Pressures

RAPID waning of the skepticism encountered by post-war pioneers in high steam pressures was evidenced by the papers and discussion presented at a meeting of the Metropolitan section of the American Society of Mechanical Engineers in New York City on Feb. 4. The papers centered about the high-pressure installations in the Edgar Station of the Edison Electric Illuminating Company, of Boston. One, written by I. E. Moultrop, and presented by Melvin D. Engle, gave a comprehensive history of the developments at Edgar Station, broadly interpreted in terms of the economic possibilities of high-pressure stations. A paper by Richard Brown was notable for its frank and clear description of operating troubles encountered and the means taken to overcome them.

The discussion brought out no disagreement with Mr. Moultrop's statements that high-pressure condensing stations can be built at practically the same cost as normal pressure stations and that high pressures involve no serious operating difficulties.

Extensive abstracts of the papers and a report of the discussion will appear in an early issue of *Power*. The following is a brief summary of the high points of the papers:

Recent high-pressure developments in the United States, said Mr. Moultrop, are a direct outgrowth of the rising fuel prices caused by the World War. Steam temperatures in this country have halted momentarily at 750 deg., but pressures in several stations have gone to 1,400 lb., which seems to be about the present economic limit for condensing stations. This high pressure is economical only with reheat between the high-pressure and low-pressure turbines. Without reheat about 400 lb. is the economic limit.

"If the design is correct, a high-pressure station need cost no more per unit of generating capacity than one designed for lower pressures," said Mr. Moultrop. This, he explained, is possible because the cost of strictly high-pressure parts is a small percentage of the total station cost and the excess cost of these items is balanced by savings in condensers, circulating pumps and tunnels, fans, coal-handling equipment, buildings, etc.

The trend at Edgar Station, Mr. Moultrop pointed out, has been to reduce water-heating surface in boilers and increase economizer and air-heating surface, with a resulting substantial increase in boiler capacity.

One of the chief remaining problems is that of securing proper speed control in the slip-ring motors driving high-pressure feed pumps. The high-pressure plant of the immediate future, according to Mr. Moultrop, will be so laid out as to simplify piping systems and reduce building costs. He concluded with the statement that the original high-pressure installation at Edgar Station was made on a strictly business basis and not merely as an interesting scientific experiment.

In the second paper Mr. Brown showed that many of the special provisions made to safeguard the original high-pressure installation proved needless and were omitted from later additions. These included pilot safety valves, a desuperheater in connection with the automatic throttle trip of the high-pressure turbine, a bypass damper in the reheater and a special laminated field in the generator connected to the high-pressure turbine.

However, certain troubles not anticipated were encountered with feed-water regulation, boiler tubes, furnace water walls and high-pressure feed pumps.

Troubles with the latest high-pressure installation include ruptured superheater and water-wall tubes. The former difficulty has been solved and a solution of the water-wall problem is in sight. After some initial changes the latest high-pressure turbine has operated satisfactorily.

Early troubles with high-pressure feed pumps appear to have been overcome, except that the slip-ring motor drive still fails to give satisfactory speed regulation.

Operating figures at Edgar Station, according to Mr. Brown, indicate a fuel saving of about 12 per cent for a plant on a complete high-pressure basis.

These papers brought out extensive discussion, notable for its confirmation of views expressed by the authors. This will be reported in connection with the abstracts of the papers.

Men in the News

J. H. KEENAN

formerly of the Turbine Design Department of the General Electric Company, Schenectady, N. Y., has recently accepted the chair of physics at Stevens Institute of Technology. Mr. Keenan made an important contribution to steam engineering last summer when he collaborated with others in extending the steam tables to include the range of high pressures and temperatures

Advanced Features Characterize Canadian Plant

ADJUSTABLE blade runners, the first ever used in a Canadian hydro development, will be employed on the six 10,000-kva. units now being installed in the big Back River hydro-electric plant near the city of Montreal. Plans for this development call for the construction of a power house which will ultimately contain ten generating units. These adjustable runners will be set to suit all conditions of flow and head, maintaining the average efficiency of the plant. Should the head of water drop from 26 ft. to 18 ft., the runners would be set accordingly and the electrical output not seriously lowered. Each unit has a separate adjustment which is made by hand mechanism; and though the generator has to be stopped and disconnected from the line, the whole operation will take less than five minutes.

Another interesting feature will be the ejector tubes which are being installed on four units. These are situated under the powerhouse, where there is no fear of freezing, and the units so equipped will pass 6,700 sec.-ft., whereas the others only pass 6,000 sec.-ft. This will give a 10 per cent increase in power by depressing the tailwater. The gates for these ejectors are motor-operated and can be opened up in three minutes.

They act under switches electrically controlled from the main switchboard. This will be the second time that ejector tubes have been used for the purpose of increasing power in Canada.

Provision is also being made in one of the dams for an experimental laboratory, and to this end a 16-ft. controlled opening is being left in the structure. In the rack chamber are bars on 6 in. centers. Any material that can pass this spacing can safely go through the wheels.

A further interesting feature will be found in the generators, which will be built up of welded steel plate and, instead of being circular in shape, will be twelve-sided, this form lending itself better than the circular to welded construction.

Work Started on Brunot Island Station

Actual construction work on the James H. Reed power station to be built on Brunot Island, Pittsburgh, for the Duquesne Light Company, has been started, according to H. W. Fuller, vice-president in charge of engineering and construction, Byllesby Engineering and Management Corporation. Orders have been placed for the major equipment, turbines, boilers, stokers and condensers.

This new station will have a rated capacity of 60,000 kw. It will be adjacent to the Duquesne Light Company's switchhouse and the present power station on Brunot Island.

The building to be constructed at this time will be large enough to house two 60,000-kw. generators and six boilers, but only one 60,000-kw. generator and three boilers will be installed now. The extra space provided is for future additions to the station capacity.

A description of this station was given in these pages on Oct. 2, 1928.

Canada Starts Production of Briquet Lignite

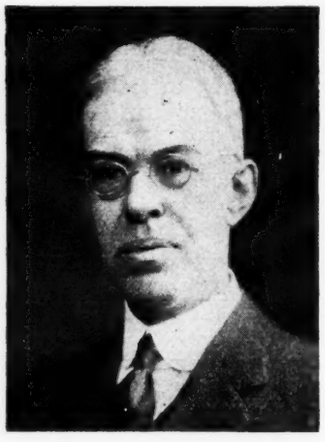
Large-scale utilization of the immense lignite coal deposits of southern Saskatchewan for the manufacture of briquets is foreshadowed in the statement made by the Canadian Premier, Mr. Gardiner, that the big plant at Bienfait, on the construction and equipment of which $600,000 of British capital has been expended, is scheduled to come into operation shortly.

In stating that Saskatchewan lignite coal will be produced in briquet form shortly after the new year at the rate of 100 tons a day, the Premier announced that the Saskatchewan government had agreed to take over the whole output during the initial period of operation until the product had been standardized and launched on the markets of the province and elsewhere. It is estimated that between 15,000 and 20,000 tons of briquets will be produced by spring, initial production of 100 tons per day being later increased to 200 tons.

S. W. Miller Dies

Samuel Wylie Miller, consulting engineer of the Union Carbide & Carbon Research Laboratories, Inc., of Long Island City, N. Y., and well known both in the United States and in Europe as a pioneer of oxyacetylene welding and an authority on its application, died on Feb. 3, at his home in Hollis, L. I.

Mr. Miller was a native of New York and received his engineer's degree from Stevens Institute in 1887. His first activities were as master mechanic for the Pennsylvania Railroad plants at Logansport and Indianapolis, Ind., and at Columbus, Ohio. Following this he was with the American Locomotive Company at Dunkirk, N. Y., and Providence, R. I., after which he founded the Rochester Welding Works at Rochester,



N. Y. In 1921 he joined the newly formed Union Carbide & Carbon Research Laboratories.

In all engineering circles Mr. Miller had been known as an outstanding figure in the advancement of oxyacetylene welding ever since its inception as a commercial process. He was a past-president of the American Welding Society and a prominent and active member of the American Society of Mechanical Engineers, American Institute of Mining and Metallurgical Engineers, American Society for Steel Treating, British Iron and Steel Institute, Institute of Metals and other scientific and engineering organizations. He was the donor of the Miller medal for work of outstanding merit in advancing the art and science of welding. He was noted for his energetic insistence upon high quality and dependable workmanship and upon the development of welding by all processes along lines scientifically well founded. His important contributions to welding were many. He is credited with having been among the first members of this profession to visualize the possibilities of oxyacetylene welding. He made a study of the subject and developed and widened the field of application of the oxyacetylene process considerably. He wrote several books on the subject and was much sought after as a lecturer on welding at engineering meetings. His loss will be keenly felt by the entire welding and engineering profession.

*Spot * News*

GOVERNOR ROOSEVELT *of New York is working out a plan for public development of the state's water powers which calls for an expenditure of $300,000,000 by the owners of this so-called "gift" of nature. The power companies, under the plan, will spent $200,000,000 more in erecting transmission lines to bring the power in where people can use it.*

* * *

CANADA'S TOTAL *power output for 1928 was 15,899 million kilowatt-hours, or 1,640 kw.-hr. per capita. In the United States the per-capita figure approximated 730 kw.-hr. Not only that: a billion and a half of those Canadian units were exported to the United States.*

* * *

MUSCLE SHOALS, *the perennial bone of contention in Congress, is the center of argument of the two Alabama Senators, who want to see its power used for fertilizer manufacture rather than for transmission to the people of the state for general purposes. If there ever was a case of it, white coal has certainly become a white elephant at Muscle Shoals.*

* * *

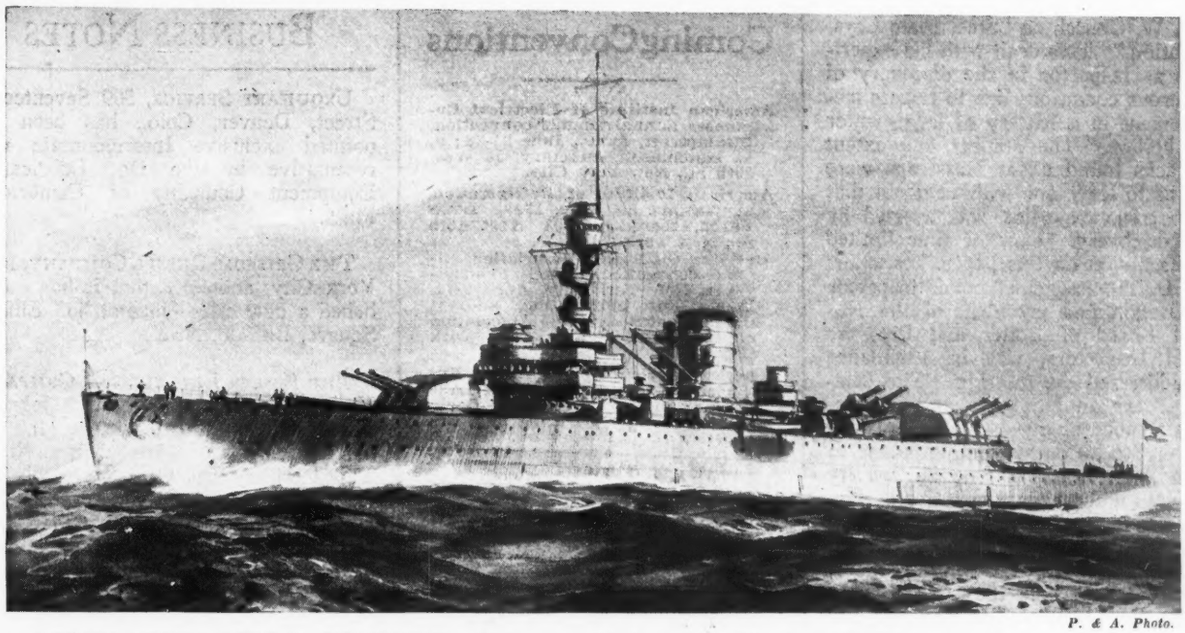
HOLD-UP MEN *in Chicago are apparently keeping abreast of metallurgical science, as evidenced by a recent report that four of them entered a warehouse and stole eight tons of nickel billets. Quantities of brass, copper, nickel-silver and aluminum were entirely ignored. Pure nickel is, of course, a semi-precious metal.*

* * *

THE HYDRAULIC LABORATORY *proposed for the United States Bureau of Standards does not seem to be meeting with the approval of Congressional committees. Observers in Washington hint that the bill itself may be no more than the match that lit the conflagration of controversy between civil and military engineers.*

* * *

AMONG THE CURIOUS CUSTOMS *which the visitors in the World Power Conference in Tokio will be able to observe, is the "anti-necking lamp law." The Japanese have advised American automobile manufacturers that this law requires a dome light to be lit in all closed cars after dark. An American commentator calls this "modern light on an ancient custom."*



P. & A. Photo.

THE FIRST DIESEL WARSHIP will be a welded vessel. She is a 10,000-ton cruiser now under construction at the Kiel yards for the German government. Her engines will reduce the usual weight of a cruiser's power plant by about one-half, but will drive her at 26 knots, with a cruising radius of 10,000 miles. The substitution of welded construction for riveting will make a further saving in weight of 1,000 tons.

A.S.M.E. Knoxville Meeting to Stress Southern Development

Technical Papers and Trips Will Feature Local Industrial Progress at Regional Meeting in March

PLANS are far advanced for the regional spring meeting of the American Society of Mechanical Engineers at Knoxville, Tenn., which will be held March 21, 22 and 23. The program has been arranged to treat of the various phases of industrial growth that have taken place in the South in recent years, and should be of wide interest to engineers from all parts of the country. In addition to two days of technical sessions, much time will be devoted to inspection trips to large industrial enterprises in and around Knoxville, and to excursions to places of scenic beauty.

Coincident with the A.S.M.E. meeting there will be a meeting of the Association of College Engineers, a group of students throughout the South. The students will join in all the society technical sessions and excursions and on Friday afternoon will provide an important feature of the program. At that time the entire campus of the University of Tennessee will be given over to a student engineering exhibit and to ceremonies of the association.

The tentative program of the sessions, which has just been announced, includes the following papers:

THURSDAY MORNING, MAR. 21

"Design of the Gorgas Steam Power Plant of the Alabama Power Company," by Prof. John M. Gallilee; "Factors in the Design of Boiler Furnaces," by Prof. F. C. Stewart, and "Design of Powdered Fuel Standby Station of the Tennessee Power Company," by H. H. Bailey.

THURSDAY AFTERNOON

Several papers on the printing industry and the marble quarrying industry. Inspection trips to quarries, marble mills and to the plant of the Aluminum Company of America at Alcoa.

THURSDAY EVENING

"Low Temperature Carbonization of Southern Appalachian Coals," by Leo Holdredge.

FRIDAY MORNING, MAR. 22

Papers on the geology and industrial development of the southern Appalachian section. Inspection trip to the plant of the American Zinc Company at Mascot.

FRIDAY AFTERNOON

Drive through industrial regions of the City of Knoxville, and an inspection trip including the Fulton Sylphon Machine Company's plant. Celebration of the College Engineers' Association.

SATURDAY MORNING AND AFTERNOON

Inspection of several industrial developments at some distance from Knoxville. Scenic trips in the surrounding mountain region.

SATURDAY EVENING

Banquet and dance.

California Inspectors Hold Annual Meeting

The Eighth Annual Convention of California Certified Boiler and Elevator Inspectors was held recently at the Civic Auditorium, San Francisco. The sessions were well attended by inspectors and by industrial engineers.

The elevator sessions were devoted largely to discussions of problems met by the inspector in the field. However, a talk by Z. F. Anderson, of the Otis Elevator Company, on "New Developments in Elevator Construction" was very instructive and emphasized the rapid progress being made in improving vertical transportation facilities. A talk by A. T. Brown, of John Roebling's Sons, reminded hearers that high car speed and rapid acceleration have also presented problems to the wire rope manufacturer and that these are being satisfactorily solved.

The boiler session included motion pictures of the various stages of shop inspection of A.S.M.E. Code boilers and air tanks; and of tests to destruction of air tanks with "orange-peel" and "bull-head" ends. Considerable time was devoted to a discussion of the A.S.M.E. Boiler Code rules and formulas and to inspection problems in the

field. An extraordinary paper was read by F. W. Church on "Steel Plate Crystallization." This dealt with his experiences as inspector in the discovery of dangerous conditions due to caustic embrittlement in a battery of large water tube boilers. The number and extent of cracks found under buttstraps were such as to leave one without doubt that a disastrous explosion was averted by their discovery. Lack of time limited the discussion on this paper.

C. D. Thomas, chief boiler inspector for Oregon and president of the National Board of Boiler and Pressure Vessel Inspectors, was in attendance and addressed the meeting. The delegates spent an enjoyable and instructive afternoon as guests of the Western Pipe & Steel Company at its plant in South San Francisco, where a variety of boilers and pressure containers were in course of construction. The meeting closed with a banquet and entertainment at the Palace Hotel, during which it was decided to hold the next convention in Los Angeles. Officers for the coming year are: Chairman, C. E. McGinnis, manager, Board of Mechanical Engineers of Los Angeles; secretary-treasurer, Jack Glennon, General Petroleum Corp.; auditor, Burt Evans, state boiler inspector at Los Angeles.

- ◆ -

Rio Grande Development

The Maverick County Water Improvement District No. 1, of Eagle Pass, Texas, has applied for a preliminary permit covering a 7,200-hp. project. It is planned to divert the necessary water from the Rio Grande at Del Rio and carry it by gravity through an open ditch and concrete tunnel for a distance of 35 miles to the power house, ten miles northwest of Eagle Pass. The power is to be used for pumping and public-utility purposes. The application is believed to have been filed in the expectation that an early agreement will be reached with Mexico covering the disposition of Rio Grande water.

Personals

Walter T. Ritter, formerly of the Burke Engineering Company, has joined the organization of the Ellison Draft Gage Company, Chicago, Ill., as sales engineer. Mr. Ritter will be at the main office and factory at 214 West Kinzie St., Chicago.

Edgar H. Bristol, president of the Foxboro Company, Foxboro, Mass., sailed from New York City on the S.S. "Santa Teresa," Jan. 31, for an extensive tour through South America.

E. A. Kerbey has been appointed Chicago manager of the Midwest Piping & Supply Company, Inc., of St. Louis, Mo. His offices will be at 208 So. La Salle St., Chicago.

Coming Conventions

American Institute of Electrical Engineers, annual summer convention, Swampscott, Mass., June 24-28; F. L. Hutchinson, secretary, 33 West 39th St., New York City.

American Institute of Refrigeration, at Washington, May, 1929. Louis Baron, secretary, 203 West 13th St., New York City.

American Oil Burner Association, annual convention, Hotel Pennsylvania, New York City, April 9-11, 1929. For information, address the headquarters of the Association at 420 Madison Ave., New York City.

American Society of Mechanical Engineers, spring meeting, Salt Lake City, Utah, July 1-4, 1929. Rochester Regional Spring meeting, Rochester, N. Y., week of May 13. Calvin Rice, secretary, 29 West 39th St., New York City.

Association of Iron and Steel Electrical Engineers, 25th annual convention, Pittsburgh, Pa., June 17-22, 1929. A. A. Stewart, secretary, Pittsburgh Steel Co., Monnessen, Pa.

Canadian Electrical Association, annual convention, to be held June 19-21, at St. Andrews-by-the-Sea, N. B. H. M. Lyster, secretary, Power Building, Montreal, Que.

Engineering Institute of Canada, annual general and professional meeting, at Hamilton, Ont., Feb. 13-15, 1929. R. J. Durley, secretary, 2050 Mansfield St., Montreal, Que.

Master Boiler Makers Association, at Atlanta, Ga., May 21-24. H. D. Vought, secretary, 26 Cortlandt St., New York City.

Midwest Power Conference and Exhibition, at Chicago, Feb. 12-16; Conference headquarters at the Palmer House. Exhibition at the Coliseum; G. E. Pfisterer, secretary 53 West Jackson Blvd., Chicago.

National Marine Engineers Beneficial Association. The 54th annual meeting will be held in Washington, D. C., Feb. 11-16, at the Hotel Hamilton.

World Engineering Conference, Tokyo, Japan, October, 1929. All correspondence should be addressed to the Secretary, World Engineering Conference, Nikon, Kogyo Club, Morunouchi, Tokyo.

Louis E. Lovett, a member of the American Society of Mechanical Engineers, has established a consulting engineering practice, with offices at 113 Hudson St., New York City. He will devote himself to consulting work on industrial power plants, refrigeration, mill engineering, etc.

Frank C. Douglas has been appointed to the sales force of The Buckeye Machine Company, manufacturer of Buckeye Diesel Engines, and will be stationed at St. Louis, Missouri. Mr. Douglas is well known in this territory having previously been connected with the American Blower Company of Detroit.

Harry L. Mitchell, president of the West Penn Railways Company, has been elected president of the West Penn Power Company. He succeeds G. M. Gadsby, who resigned recently. Mr. Mitchell has been identified with West Penn operations for more than 25 years. He will continue as president of the West Penn Railways Company.

Business Notes

Urquhart Service, 509 Seventeenth Street, Denver, Colo., has been appointed exclusive Intermountain representative by the Dot Lubricating Equipment Company of Cambridge, Mass.

The Griscom-Russel Company, New York City, announce that it has established a new sales office at 433 Ellicott Square, Buffalo, N. Y.

The Boiler Engineering Company, Newark, N. J., announces that John D. Hiles, Oliver Bldg., Pittsburgh, Pa., has taken over the Pittsburgh territory. This territory was formerly handled by G. T. Swarts, recently deceased. Announcement is also made that the Cleveland territory will in the future be handled by the Power Auxiliary Company under the direction of H. F. Bauer, in Cleveland.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run, except Pittsburgh gas slack:

Bituminous (Net Tons)	Market Quoting	Price per Ton
Navy Standard	New York	$2.35@$2.40
Kanawha	Columbus	$1.25@1.45
Smokeless	Cincinnati	2.25
Smokeless	Chicago	2.25
S. E. Kentucky	Chicago	1.35@ 1.60
Steam	Pittsburgh	1.60@ 1.70
Gas Slack	Pittsburgh	1 00@ 1.10
Big Seam	Birmingham	1.25@ 1.50
Anthracite (Gross Tons)		
Buckwheat	New York	$2.75@$3.25
Barley	New York	1.50@ 1.75

FUEL OIL

New York—Feb. 7, f.o.b. Bayonne, N. J., 28@34 deg., Baumé, industrial use, tank-car lots, 4⅜c. per gal.; 36@40 deg., furnace, tank-car lots, 6½c. per gal.

St. Louis — Jan. 30, tank-car lots, f.o.b. St. Louis, 24@26 deg., $1.3959 per bbl. or 42 gal.; 26@28 deg., $1.4459 per bbl.; 28@30 deg., $1.4959 per bbl.; 30@32 deg., $1.5459 per bbl.; 32@36 deg., gas oil, 4.526c. per gal.; 38@40 deg., distillate, 5.605c.

Pittsburgh—Jan. 28, f.o.b. local refinery, 30@34 deg., fuel oil 5c. per gal.; 36@40 deg., 5¼c. per gal.

Philadelphia—Jan. 22, 13@19 deg., $0.95@$1.02 per bbl. or 42 gal.; 22 deg. plus, $1.47@$1.53 per bbl.; 26@30 deg., $2.00@$2.06 per bbl.

Cincinnati — Feb. 5, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 5c. per gal.; 26@30 deg., 5¼c. per gal.; 30@32 deg., 5.95c. per gal.

Chicago—Feb. 2, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 90c. per bbl. or 42 gal.; 22@26 deg., 65c. @70c. per bbl; 26@30 deg., 90c. per bbl.; 30@32 deg., $1.15 per bbl.

Boston—Jan. 28, tank-car lots, f.o.b. 12@14 deg. Baumé, 4.5c. per gal.; 28@32 deg., 5.65c. per gal.

Dallas—Feb. 2, f.o.b. local refinery, 26@30 deg., $1.20 per bbl. or 42 gallons.

THE ELLIOTT COMPANY of Jeannette, Pa., announces the following changes in its personnel: H. D. Storer has been appointed manager of the marine department, with headquarters in New York City. F. T. Cooper, formerly Cincinnati district manager, is going to the Pacific Coast with the Elliott Company, of California, and will open offices in either Seattle or Portland. J. R. Lemmon is being transferred from manager of the Baltimore office to manager of the Cincinnati district office. H. C. Hale, formerly special representative in Cleveland, goes to Baltimore as district manager. J. H. Strickler has been appointed Pittsburgh district manager.

TRADE CATALOGS

PUMPS — Wilson-Snyder, Pittsburgh, Pa., has published an eight-page leaflet describing its main line station pipeline pumps for moving oil, etc. The pumps are illustrated and described.

INDUSTRIAL HEATERS — A leaflet recently issued by the Buffalo Forge Company, Buffalo, N. Y., describes this manufacturer's "Lowboy" and "Highboy" type industrial heating units. Dimension diagrams and illustrations of installed heaters are included.

STEEL FITTINGS—A bulletin containing 24 pages of tables, diagrams and descriptive material has been published by the Stockham Pipe & Fittings Company of Birmingham, Ala. It contains data on steel pipe fittings of all sizes and applications.

OIL SWITCHES—The Pacific Electric Manufacturing Corporation, San Francisco, Calif., presents a twelve-page bulletin, No. 21, describing a line of oil circuit breakers for group mounting. Many detail drawings and installation diagrams are included. Current transformers, high-voltage testing sets, and electric furnaces are also briefly treated in this bulletin.

FURNACES—The Stratton Engineering Corporation, New York City, has published an attractive nine-page booklet on its vertical jet furnaces. The text is accompanied by numerous layout drawings.

With the Society Sections

A. S. M. E., Detroit Section. Meeting, Feb. 13, at the Detroit Engineering Society Clubhouse, 8 p.m. Subject: "The Detroit River as a Great Power Asset," by J. W. Parker, chief engineer, Detroit Edison Company.

A. S. M. E., Knoxville Regional Meeting, Mar. 21-23, 1929. Technical program and trips to points of interest.

American Water Works Association, Montana Section. Annual convention, to be held April 4 and 5 at Great Falls, Mont.

American Water Works Association, Rocky Mountain Section. Annual meeting, to be held Feb. 14 and 15, at Denver, Colo.

Engineers' Club of St. Louis, Meeting Feb. 13, 1929. Subject: "Steam Storage and Steam Distribution," by R. A. Longworthy, vice-president and general manager of Ruths Accumulator Company.

Louisiana Engineering Society. Monthly meeting, Feb. 25, at New Orleans. Subject: "Electric Welding of Steel Buildings," by F. P. McKibben.

New Plant Construction

COMPILED BY THE MCGRAW-HILL BUSINESS NEWS DEPARTMENT, WHICH IS PREPARED TO FURNISH A MORE COMPLETE DAILY SERVICE TO THOSE WHO WISH IT

Arizona—Bureau of Indian Affairs, 18th and 19th St., Washington, D. C., awarded contract for the construction of a power house and transmission line at Coolidge dam to Westinghouse Electric & Mfg. Co., Hibbs Bldg., Washington, D. C. Estimated cost $180,000.

Calif., Los Angeles — Four Hundred Fourteen Rossmore Inc., 414 Guaranty Bldg., will soon award contract for a 13 story apartment building, including electric elevators, etc. Estimated cost $700,000. L. A. Bryant, 316 Spring Arcade Bldg., is architect.

Calif., Los Angeles — Merchants Garage Building Corp. Inc., is having preliminary plans prepared for a 12 story store and office building, etc., including steam heating system, elevators, etc., at Olive St. between 6th and 7th Sts. Estimated cost $750,000. W. C. Pennell, 804 South Vermont Ave., is architect.

Calif., Los Angeles — Monarch Hotels, Inc., 912 Story Bldg., awarded contract for the construction of a 12 story hotel and apartment building at 5th and Figuroa Sts., to E. N. Frame, 912 Story Bldg. Estimated cost $887,000. Steam heating and electric elevators, etc., will be installed.

Calif., Los Angeles—Southern California Edison Co., 306 West 3rd St., awarded contract for the construction of a 13 story office building at 5th and Grand Ave., to P. J. Walker Co., 1111 W. M. Garland Bldg., Estimated cost $2,000,000. Steam heating system, elevators, etc., will be installed.

Calif., Pleasanton—City plans an election to vote bonds for waterworks improvements, including pump, etc.

Calif., San Francisco—Hotel Stewart, C. A. Stewart, Pres., 353 Geary St., plans the construction of a 15 story hotel and stores building at Geary and Powell Sts. Estimated cost $3,000,000. Architect not announced.

Calif., San Francisco — Pacific Gas & Electric Co., 245 Market St., is having plans prepared for the construction of a steam generating plant, 300,000 hp. capacity at 23rd and Louisiana Sts. Estimated cost approximately $11,000,000. Private plans.

Calif., Alturas — City is having plans prepared for the construction of an electric power plant to develop 800 hp. Estimated cost $75,000. S. Muchin, Alturas, is engineer.

D. C., Washington — Dept. of Interior awarded contract for the construction of a nurses' home, power house, etc., at Freedmen's hospital to Bahen & Wright, 1223 New York Ave. N. W. Estimated cost $149,700.

Ill., Chicago — W. N. McChesney, 30 North La Salle St., awarded contract for the construction of an 8 story stores and office building at Grand, Ohio, Rush Sts. and Michigan Ave., to Lundorff-Bicknell Co., 100 North La Salle St. Estimated cost $2,000,000.

Ill., Chicago—T. D. Randall, 5110 Kenwood Ave., had plans prepared for the construction of a 12 story apartment building at 6319-21 Kenwood Ave. Estimated cost $600,000. W. L. Hoffman, 718 West 63rd St., is architect.

Ill., Chicago—University of Chicago, 189 West Madison St., awarded general contract for the construction of a 96 x 98 ft. power plant at 6043-6059 Blackstone Ave. to Jacobsen Bros., 53 West Jackson Blvd. Estimated cost $200,000.

Ill., Chicago — H. Zisook, 4655 Lake Park Ave., is having plans prepared for a 4 story hotel, including four electric elevators, etc., at 6121-6135 Kenwood Ave. Estimated cost $650,000. T. R. Bishop & Son, 35 South Dearborn St., are architects.

Ind., Evansville—Crescent Coal Co. is receiving bids for the construction of an 88 x 91 ft. boiler house. Estimated cost $48,000. Thole & Legeman, 307 American Trust Co., are architects.

Ind., Indianapolis — Tower Realty Co., 612 Illinois Bldg., is having preliminary plans prepared for a 10 story office building, including elevators, etc., at Monument Circle and Market St. Estimated cost $1,000,000. Rubush-Hunter, 430 American Central Life Bldg., are architects.

Ia., Muscatine—Muscatine-Louisa Counties Drainage Dist. 13, C. H. Pitchforth, Auditor, will receive bids until Feb. 15 for electrification of pumps 1 and 3 at Port Louisa Station. Central States Engineering Co., Muscatine, is engineer.

Mich., Detroit — Times Publishing Co., West Park Pl., awarded contract for the construction of a 6 story publishing plant, to H. G. Christman-Burke Co., Fisher Bldg. Estimated cost $1,000,000. Steam heating system, boilers, elevators, etc., will be installed.

Minn., Minneapolis — Northwestern National Bank, 467 Marquette Ave., and E. S. Donaldson, 6th St. and Nicollet Ave., awarded contract for the construction of a 16 story bank and office building at Marquette Ave. and 6th St., to C. F. Haglin & Sons Co., 226 Lumber Exchange. Estimated cost $4,000,000. Steam heating system, elevators, etc., will be installed.

Minn., Minneapolis—St. Barnabas Hospital, G. S. Grimes, Chn. Bd. of Trustees, 538 McKnight Bldg., will soon award contract for the construction of a power plant, etc., at 6th St. between 9th and 10th Aves. S. Estimated cost $200,000. Magney & Tusler, 104 South 9th St., are engineers.

Mo., Columbia — City plans extensions and improvements to power plant including 5,000 kva. turbine, condenser and switchboard. Burns & McDonnell Engineering Co., 401 Interstate Bldg., Kansas City, is engineer.

Mo., Licking — Syndicate, c/o W. R. Fisher, Inc., Boatmen's Bank Bldg., St. Louis, Engr., is having preliminary plans prepared for the construction of a hydroelectric power dam, 20 ft. high and 300 ft. long on the Piney River, near here, to generate 400 hp. Estimated cost $100,000.

Mo., St. Louis—Wagner Electric Corp., 6400 Plymouth Ave., awarded contract for the construction of a 1 story, 120 x 380 ft. transformer building, and 5 story, 80 x 120 ft. office and manufacturing building, to Hercules Construction Co., Wainwright Bldg.

N. J., Newark — Bd. of Chosen Freeholders, Hall of Records Bldg., awarded contract for the construction of a court house at Market and High Sts., to W. D. Bigelow, 10 East 43rd St., New York. Estimated cost $1,000,000. Steam heating system, etc., will be installed.

N. Y., Brooklyn—Dept. of Welfare, Municipal Bldg., New York, plans the construction of a 10 story hospital building for Kings County Hospital at Clarkson and East New York Aves. here. Estimated cost $6,000,000. L. R. Ward, 1420 Lexington Ave., New York, is architect.

N. Y., New York—American Museum of Natural History, 77th St. and Columbus Ave., will receive bids in May for the construction of a power station and service building. Estimated cost $750,000. Trowbridge & Livingston, 527 5th Ave., are architects.

N. Y., New York—East 79th St. Realty Corp., M. J. Kramer, Pres., plans a 16 story apartment building at 1031 Madison Ave. Estimated cost $1,150,000. G. F. Pelliam, 570 7th Ave., is architect.

N. Y., New York—R. W. Goelst, 16 East 47th St., plans a 14 story apartment building at 437 East 57th St. Estimated cost $1,100,000. R. Candela, 578 Madison Ave., is architect.

N. Y., New York — New York Realty Operators, Inc., I. Feldman, Pres., 119 West 57th St., plans the construction of a 15 story apartment building at 435 West 57th St. Estimated cost $2,000,000.

N. Y., New York—Realty Assets Corp., 17 East 49th St., plans the construction of a 15 story apartment building at East River and 48th and 49th Sts. Estimated cost $6,000,000.

N. Y., New York — Shroder & Koppel, 420 Lexington Ave., plans the construction of a 15 story apartment building at Madison Ave. and 96th St. Estimated cost $1,500,000.

N. C., Durham—American Tobacco Co., awarded general contract for the construction of a power plant to Fiske-Carter Construction Co., Greenville, S. C. Estimated cost $350,000.

O., Cleveland—Dept. of Public Welfare, D. S. Blossom, Dir., is having preliminary plans prepared for a 7 story addition to hospital on Scranton Rd. Estimated cost $1,430,000. H. Kregelius, 604 City Hall, is architect.

O., Youngstown — Central Savings & Loan Co., T. B. Van Alstine, Pres., 1 West Federal St., awarded contract for a 17 story bank and office building, to Heller Bros., Thurman and Furnace Sts. Estimated cost $600,000.

Okla., Oklahoma City — Hurley Park Improvement Co., 317 Roberts Bldg., will build a 15 story apartment building. Estimated cost $1,000,000. N. E. Peters, 1006 Ovar Leslie Bldg., Kansas City, Mo., is architect. Work will be done by separate contracts.

Pa., Philadelphia — Pennsylvania R.R., Broad St. Station, plans the construction of a 22 story office building at 16th, 17th, Cuthbert Sts. and Pennsylvania Ave. Estimated cost $5,000,000. Graham, Anderson, Probst & White, Railway Exchange Bldg., Chicago, Ill., are architects. T. J. Skillman, is chief engineer.

Pa., Philadelphia—Reading Co., Reading Terrace, awarded contract for the construction of a 12 story commercial building at Noble, 13th, Broad and Callowhill Sts., to W. Steele & Sons Co., 15th and Cherry Sts. Estimated cost $3,000,000.

Pa., Pittsburgh — St. Francis Hospital, 45th St., is having preliminary plans prepared for the construction of a 6 story addition to hospital. Estimated cost $1,500,000. Schmidt, Garden & Erickson, 104 South Michigan Ave., Chicago, Ill., are architects.

Tenn., Memphis — Producers Milk Co., Inc., J. H. Tull, Mgr., Linden Circle, awarded contract for the construction of a dairy plant, including 32 x 72 ft. power house, boiler room and refrigeration equipment, etc., at South Bellevue and Beechwood Sts., to L. E. Joyner & Co., 163 South 3rd St. Estimated cost $150,000.

Tex., Brackettville—City, c/o E. N. Oxten, Mayor, will soon award contract for waterworks improvements to include pump house, two 250 g.p.m. centrifugal pumps direct connected to motors, 75,000 gal. tank on tower, etc. Estimated cost $40,000. H. G. Olmstead, El Paso, is consulting engineer.

Tex., Donna—Caps & Parker, will build a 60 ton ice and packing plant. Estimated cost $60,000. Work will be done by day labor.

Tex., San Antonio — Alamo National Bank, c/o E. L. Brown, V. Pres., 128 West Commerce St., awarded contract for the construction of a 22 story bank and office building at St. Marys and Commerce Sts., to McKenzie Construction Co., Travis Bldg. Estimated cost $1,000,000. Mechanical equipment will be installed.

B. C., Ruskin—British Columbia Electric Railway Co., 425 Carroll St., Vancouver, will receive bids until Feb. 14 for the construction of a hydro-electric power dam, 183 ft. high and 325 ft. long on Stave River in connection with Ruskin power development. Estimated cost $1,800,000. E. E. Carpenter, 425 Carroll St., Vancouver, is engineer.

Ont., Hamilton — Hamilton By-Product Coke Ovens Ltd., Ft. Depew St., will build a 40 x 250 ft. booster house. Estimated cost $40,000. Hutton & Sauter, 6 James St. S., are architects. Work will be done by day labor.

Ont., Hamilton — Hamilton Hydro Co. Ltd., 12 King St. E., plans the construction of a remote control electric sub-station, including automatic sub-station and switching equipment, cables, switchboards, etc., on Dunburn St. N. Estimated cost $68,000. Private plans.

Ont., London—Utilities Commission, plans the construction of a new sub-station, also extensions to electric lines and installation of additional cables. Estimated cost $100,000. E. V. Buchanan, is engineer.

Ont., Swansea—Village will soon receive bids for the construction of a sewage disposal plant and pumping station, etc. Estimated cost $125,000. Wynne-Roberts Son & McLean, Metropolitan Bldg., Toronto, are engineers.

Ont., Toronto—Alcazar Apartments Ltd., 606 C. P. R. Bldg., awarded contract for a 7 story apartment hotel at Gerrard and Jarvis Sts. to United Construction Co., Bloor-Bay Bldg. Estimated cost $600,000. Steam heating system, elevators, etc. will be installed.

Ont., Toronto—H. Falk, Central Building, plans the construction of a 23 story office building, including steam heating system, elevators, etc., on Richmond St. W. Estimated cost $2,000,000. Baldwin & Greene, 24 Bloor St. W., are architects.

Ont., Windsor—Catholic Diocese of London, M. F. Fallon, London, is having plans prepared for the construction of a hospital, including steam heating system, etc., on South Windsor St. Estimated cost $1,000,000. Pennington & Boyde, 1002 Security Bldg., are architects.

Equipment Wanted

Boiler and Turbine—Gulf Public Service Co., New Iberia, La., and Jacksonville, Tex., plans the installation of one 500 hp. boiler and 2,500 kva. turbine for proposed extensions and improvements to plant at Jacksonville, Tex. Estimated cost $300,000.

Condenser—Hydro Electric Power Commission of Ontario, 190 University Ave., Toronto, Ont., plans the installation of a 5,000 kva. synchronous condenser in Oshawa sub-station. Estimated cost $60,000.

Pumping Equipment—City of Wayzata, Minn., plans to purchase pumping equipment, etc., for proposed waterworks system. Estimated cost $60,000.

Pumping Equipment — Dept. of Water Supply, City Hall, Lynn, Mass., is receiving bids for equipment for pumping plant on Walnut St.

Pumps — E. R. Blackwell, Brockville, Ont., City Engr., will receive bids in spring for one 200 g.p.m. and two 400 g.p.m. pumps for proposed sewage disposal plant.

Pumps—City of South Bend, Ind., will receive bids until Feb. 19, for two 700 g.p.m. booster pumps, etc., for proposed waterworks improvements.

Pumps and Motors — City of Arroyo Grande, Calif., plans to purchase pumps and motors, etc., for proposed waterworks improvements. Estimated cost $35,000.

Pumps, Motors, Etc.—Bd. of Water Commissioners, F. P. Book, Pres., Detroit, Mich., will receive bids until Feb. 27 for two 5,000 g.p.m. vertical dewatering pumps direct connected to 720 r.p.m. electric motors; two 300 g.p.m. horizontal sump pumps direct connected to electric motors for Low Lift Plant, Springwells Station.

Sub-Station Equipment — Utilities Commission, London, Ont., prices on equipment for proposed substation, etc. Estimated cost $100,000.

Industrial Projects

Calif., Emeryville—FACTORY—Western Electric Co., 680 Folsom St., San Francisco, will soon award contract for the construction of a 5 story factory here. Estimated cost $500,000. Private plans.

Conn., Hartford — MACHINERY FACTORY — Hartford Special Machinery Co., 287 Homestead Ave., had plans prepared for a 1 and 2 story factory on Homestead Ave. Estimated cost $40,000. Buck & Sheldon Inc., 60 Prospect St., are architects.

Fla., Port Tampa—REFINERY ADDITION and POWER PLANT — Asiatic Petroleum Co., c/o Shell Union Oil Co., 65 Broadway, New York, will build an additional unit to plant, including power plant here. Estimated cost $250,000. Work will be done by separate contracts.

Mich., Detroit — MACHINE SHOP and CENTRAL POWER PLANT — Cadillac Motor Car Co., 2860 Clark Ave., awarded contract for a 4 story, 220 x 395 ft. machine shop, including central power plant to A. A. Albrecht Co., Penobscot Bldg.

Mich., Detroit — AUTOMOBILE FACTORY ADDITION and CENTRAL POWER PLANT—Packard Motor Car Co., East Grand Blvd., awarded contract for a 1 and 4 story, 40 x 285 and 145 x 418 ft. addition to factory, including central power plant on Balfour Ave., to Everett Winters Co., 1651 East Grand Blvd. Estimated cost $750,000.

Mich., Detroit—AIRCRAFT PLANT and POWER HOUSE—Warner Aircraft Corp., 4042 West Jefferson Ave., awarded contract for a 1 and 2 story aircraft plant, including power house at 8 Mile Rd. and Town Line Rd. to Krieghoff Co., French Rd. Estimated cost $500,000.

N. J., Newark—FENCE FACTORY and CENTRAL HEATING PLANT — Atlas Fence Co., Inc., 37 Verona Ave., will build a 1 story factory, including central heating plant at 35-49 Verona Ave. Estimated cost $40,000. A. H. McCully, 61 Schley St., is architect. Work will be done by separate contracts.

O., Cincinnati—MEDICINE FACTORY—Mosby Medicine Co., 3203 Reading Rd., plans the construction of a 7 story, 75 x 210 ft. factory on Lincoln St. Estimated cost $500,000. J. C. Grunkemeyer, Eastern Ave., is architect.

O., Cleveland — BRUSH FACTORY — Manufacturers Brush Co., R. R. Radinse, Pres., 1950 West 114th St., awarded contract for a 1 story, 80 x 240 ft. factory and office on Elmwood Ave. and Berea Rd., to R. W. Kretchmer, 3700 West 130th St. Estimated cost $100,000.

O., Dayton — CASH REGISTER FACTORY—National Cash Register Co., Main and K Sts., plans the construction of a 6 story factory. Private plans.

O., Maple Heights (br. Cleveland) — METAL PRODUCTS FACTORY — Lake Erie Metal Products Co., J. F. Strand, Gen. Mgr., Dunham Rd., awarded contract for a 1 and 2 story, 75 x 100 ft. factory, to J. Heitzel, 5177 Theodore Ave. Estimated cost $40,000.

Pa., Ambridge—TUBE MILL ADDITION—Spang Chalfant Co., will build a 1 story, 240 x 750 ft. addition to tube mill. Estimated cost $50,000. Work will be done by separate contracts.

Tex., El Paso—COPPER REFINERY—Nichols Copper Co., c/o C. W. Nichols, Pres., 25 Broadway, New York, plans the construction of a copper refinery, 100,000 tons annual capacity, to include 60 x 200 ft. machine shop, 40 x 200 ft. warehouse, office, etc. Estimated cost $150,000. Work will be done by separate contracts.

Wis., Milwaukee—HAMMER FACTORY—Cutler Hammer Co., 12th and St. Paul Sts., plans the construction of a hammer factory. Estimated cost $2,000,000. Architect not selected.

Ont., Hamilton—COTTON FACTORY—Canadian Cottons Ltd., A. E. Adam, Mgr., 429 James St. N., is having plans prepared for the construction of a factory on King St W. Estimated cost $500,000. B. H. Prack, 42 James St. N. is architect.

Ont., Toronto—PAD and PAPER FACTORY—Canadian Pad & Paper Co., 520 King St. W., awarded contract for a 4 story, 105 x 105 ft. factory on Madison Ave. to Sullivan & Fried, 81 Victoria St. Estimated cost $150,000.

PRICES - MATERIALS - SUPPLIES

Electrical prices on following page are to the power plant by jobbers in the larger buying centers east of the Mississippi. Elsewhere the prices will be modified by increased freight charges and by local conditions.

SINCE LAST MONTH

STEEL shafting and screw stock, cold drawn, rose 10c. per 100 lb. at New York warehouses, Feb. 1, 1929. Prices of the principal hot-rolled steel materials remain firm and unchanged. Quotations on round-head rivets appear to vary in the current market. One large dealer, for instance, quotes structural rivets at $4.50 per 100 lb., for full kegs delivered out of warehouse stocks, in New York. Still another, quotes 50c. per 100 lb. higher on these rivets. Rubber-covered copper wire rose sharply during the month, while prices of armored cable are about $1.50 per 1,000 ft. under levels of Jan. 8, 1929.

POWER-PLANT SUPPLIES

HOSE—Quotations at New York warehouses:

	Fire Protection	50-Ft. Lengths
Underwriters' 2½-in., coupled, single jacket	(net) 60c. per ft.	
Common, 2½-in., cotton, rubber-lined	80c. per ft. list, less	50%

Air—Best grade

¾-in., per ft.	3-ply	$0.30	4 ply	$0.36

Steam—Discounts from List

First grade 40% Second grade 45% Third grade 50–10%

RUBBER BELTING—List price 6-in., 6 ply, $1.83 per lin.ft. The following discounts from list apply to rubber transmission belting:

Best grade 50% Second grade 60%

LEATHER BELTING—List price, 24c. per lin.ft., per inch of width, for single ply, at New York warehouses:

Grade	Discount from list
Medium	30–10%
Heavy	30–5%

RAWHIDE LACING—For cut, best grade, 30–5%; 2nd grade, 45–5%. For laces in sides, best, 57c. per sq.ft.; 2nd, 52c., net. Semi-tanned, cut, 30–5%.

PACKING—Prices per pound at New York warehouses:

Rubber and duck for low-pressure steam, ⅛ in.	$0.90
Asbestos for high-pressure steam, ⅛ in.	1.75
Duck and rubber for piston packing	.90
Flax, regular	1.15
Flax, waterproofed	1.70
Compressed asbestos sheet	.85
Wire insertion asbestos sheet	1.20
Rubber sheet	.45
Rubber sheet, wire insertion	.75
Rubber sheet, duck insertion	.55
Asbestos packing, twisted or braided and graphited, for valve stems and stuffing boxes	1.40
Asbestos wick, ½- and 1-lb. balls	.50

PIPE AND BOILER COVERING—Discounts, New York warehouses, are as follows:

85% magnesia, high pressure		50%
Asbestos, air cell, for low-pressure heating and return lines	4-ply	70%
	3-ply	72%
	2-ply	74%

PORTLAND CEMENT—New York, $2.25@$2.35 per bbl. without bags, delivered by truck to site of job. Bag charge, 40c. per bbl.

STRUCTURAL STEEL—New York delivered price, beams and channels, 3 to 15-in.; angles, 3 to 6-in., ¼-in. thick; tees, 3-in. and larger; and plates, ¼-in. thick and heavier; all $3.30 per 100 lb. in lots of 250 to 3,999 lb.

COTTON WASTE—The following prices are in cents per lb., at warehouse:

	New York	Cleveland	Chicago
White	10.00@13.50	16.00	15.00
Colored	9.00@13.00	12.00	12.00

WIPING CLOTHS—Prices per pound in lots of about 600 lb., for washed white wipers, as follows:

Chicago	$0.16
New York	.16@.16½
Cleveland (per thousand)	38.00

LINSEED OIL—These prices are for raw oil in barrels, f.o.b., in 1 to 4 bbl. lots:

	New York	Cleveland	Chicago
Per pound	$0.108	$0.11	$0.11

WHITE AND RED LEAD—Per 100-lb. keg, base price, f.o.b. New York:

	Dry	In Oil
Red	$13.25	$14.75
White	13.25	13.25

RIVETS—The following quotations are allowed for fair-sized orders from warehouse:

Tank rivets, ⅞-in. diameter and smaller list, (Apr. 1, 1927) less 60% in full packages, for immediate delivery from warehouse stocks in New York and vicinity.

Structural rivets, round head, per 100 lb.:

New York	$4.50*
Chicago	3.60
Pittsburgh mill	2.90

*Price is for full packages; broken package lots, $6.00 net, delivered.

REFRACTORIES—Prices in car-loads, f.o.b. plant:

Chrome brick, eastern shipping points	per net ton	$45.00
Chrome cement, 40@50% Cr_2O_3, in bulk	per net ton	22@25
Chrome cement, 40@50% Cr_2O_3, in sacks	per net ton	26@29
Magnesite brick, 9-in. straights	per net ton	65.00
Magnesite brick, 9-in. arches, wedges and keys	per net ton	71.50
Magnesite brick, soaps and splits	per net ton	91.00
Silica brick, Mt. Union, Pa.	per M	43.00
Clay brick, 1st quality, 9 in. shapes, Pennsylvania	per M	43@46
Clay brick, 1st quality, 9 in. shapes, Ohio	per M	43@46
Clay brick, 1st quality, 9 in. shapes, Kentucky	per M	43@46
Clay brick, 1st quality, 9 in. shapes, Maryland	per M	43@46
Clay brick, 2nd quality, 9 in. shapes, Pennsylvania	per M	35@38
Clay brick, 2nd quality, 9 in. shapes, Ohio	per M	35@38
Clay brick, 2nd quality, 9 in. shapes, Kentucky	per M	35@38
Clay brick, 2nd quality, 9 in. shapes, Maryland	per M	35@38
Chrome ore crude, 40@50%	per net ton	18.00@22.50

BABBITT METAL—Delivered, New York, cents per lb.:

Genuine, highest grade	67.00
Commercial genuine, intermediate grade	53.00
Anti-friction metal, general service	31.50
No. 4 babbitt (f.o.b.)	12.25

COLD DRAWN STEEL—Shafting and screw stock, warehouse prices per 100 lb., base, are as follows:

	New York	Cleveland	Chicago
Round or hexagon	$3.50	$3.65	$3.60
Flat or square	4.00	4.15	4.10

BOILER FITTINGS—F.o.b. warehouse, Jersey City, N. J., discounts from list:

Copper ferrules	70%
Boiler flanges	65-5%
Boiler stay bolts	60%
Boiler patch bolts	20%
Boiler fitting-up bolts	45%
Pressed steel boiler lugs	10%

WROUGHT PIPE—The following discounts from list are for large mill lots at Pittsburgh mill:

BUTT WELD

	Steel Black	Steel Galv		Iron Black	Iron Galv
Inches			Inches		
1 to 3	62%	50½%	1 to 1¼	30%	13%

LAP WELD

2	55%	43½%	2	23%	7%
2½ to 6	59%	47½%	2½	26%	11%
7 and 8	56%	43½%	3 to 6	28%	13%
9 and 10	54%	41½%	7 to 12	26%	11%
11 and 12	53%	40½%			

BUTT WELD, EXTRA STRONG, PLAIN ENDS

1 to 1½	60%	49½%	1 to 1½	30%	14%
2 and 3	61%	50½%			

LAP WELD, EXTRA STRONG, PLAIN ENDS

2	53%	42½%	2	23%	9%
2½ to 4	57%	46½%	2½ to 4	29%	15%
4½ to 6	56%	45½%	4½ to 6	28%	14%
7 and 8	52%	39½%	7 and 8	21%	7%
9 and 10	45%	32½%	9 to 12	16%	2%
11 and 12	44%	31½%			

BOILER TUBES—Following are net prices per 100 ft. at New York warehouses on tubes manufactured according to specifications of the American Society of Mechanical Engineers:

Size	Lapweld Steel	C. C. Iron	Seamless Steel
1			$17.07
1¼			19.20
1½		$38.00	17.92
1¾		28.50	20.48
2	$17.33	25.00	20.24
2¼	19.84	28.25	23.00
2½	21.60	34.00	26.03
3	25.50	42.50	27.04
3¼	30.25	49.50	30.67
3½	31.50	52.75	33.33
4	38.03	67.00	40.11

These prices are net, per 100 ft., based on stock lengths. If cut to special lengths, billing will be based on the entire stock lengths.

In addition to the above, standard cutting charges are as follows:

2 in. and smaller.. 5c. per cut. 3 in..... 9c. per cut.
2¼ and 2½ in..... 6c. per cut. 3½ to 4 in.... 10c. per cut.

ELECTRICAL SUPPLIES

ARMORED CABLE—Price per 1,000 ft.—5 per cent. 10 days.

B. & S. Size	Two Cond. M Ft.	Three Cond. M Ft.	Two Cond. Lead M Ft.	Three Cond. Lead M Ft.
No. 14 solid	$29.50 (net)	$45.00 (net)	$180.00	$220.00
No. 12 solid	136.00	180.00	225.00	275.00
No. 10 solid	185.00	235.00	275.00	325.00
No. 8 stranded	305.00	375.00	420.00	500.00
No. 6 stranded	440.00	530.00	615.00	

From the above lists discounts are:		Lead Covered
Less than coil lots	50%	30%
Coils to 1,000 ft.	60%	35%
1,000 to 5,000 ft.	65%	38%
5,000 ft. and over	67%	40%

CONDUIT—Price per 1,000 ft.; **ELBOWS AND COUPLINGS**, per 100 pieces, extra f.o.b. New York warehouse. Discount of 5 per cent. for payment in 10 days. Delivery charges, approximately 5 per cent. additional; 10,000 lbs. and over delivered free.

Size In.	Conduit Black Per M	Conduit Galvanized Per M	Elbows Black Per C	Elbows Galvanized Per C	Couplings Black Per C	Couplings Galvanized Per C
¾	$56.50	$61.34	$7.76	$8.83	$4.52	$4.92
1	72.07	78.63	10.21	11.63	6.46	7.03
1	103.31	113.00	15.10	17.21	8.39	9.13
1½	139.77	152.88	20.51	23.07	11.78	12.75
1¼	167.12	182.79	27.34	30.76	14.56	15.75
2	224.85	245.94	50.13	56.40	19.41	21.01
2½	355.50	388.85	82.03	92.28	27.73	30.01
3	464.88	508.50	218.74	246.10	41.59	45.01
3½	585.30	637.74	483.04	543.46	55.46	60.02
4	714.17	776.30	558.23	628.06	69.32	75.02

CONDUIT BODIES AND FITTINGS—Black or galvanized.

	Less than $10 list	$10 list to $100	$100 list and over
Standard package	10%	20%	28%
Less than standard package	5%	10%	20%

CUT-OUTS—Following are net prices, each, in standard-package quantities:

CUT-OUTS, PLUG, SOLID, NEUTRAL OR 2-FUSE

S. P. M. L.	$0.12	D. P. D. B.	$0.31
D. P. M. L.	.16	T. P. S. B.	.35
T. P. M. L.	.27	T. P. D. B.	.47
D. P. S. B.	.16		

CUT-OUTS, N. E. C. FUSE, SOLID, NEUTRAL OR 2-FUSE

	0-30 Amp.	31-60 Amp	60-100 Amp.
D. P. M. L.	$0.27	$0.70	$1.75
T. P. M. L.	.40	1.00	2.30
D. P. S. B.	.35	.87	
T. P. S. B.	.67	1.50	
D. P. D. B.	.65	1.75	
T. P. D. B.	1.12	3.00	
T. P. to D. P. D. B.	.75	2.10	

FLEXIBLE CORD—Price per 1,000 ft. in coils of 250 ft.:

No. 18 cotton reinforced heavy		$18.00
No. 16 cotton reinforced heavy		21.00
No. 18 cotton reinforced light		13.00
No. 16 cotton reinforced light		18.00
No. 18 cotton Canvasite cord		14.60
No. 16 cotton Canvasite cord		16.90
No. 16 super service cord or similar (2 wire) in 1,000 ft.	$70.80	*76.70
No. 14 super service cord or similar (2 wire) in 1,000 ft.	106.20	*115.05

*Less than 1,000 ft.

NATIONAL ELECTRIC CODE FUSES, NON-REFILLABLE—

250-Volt	Std. Pkg.	List	600-Volt	Std. Pkg.	List
3-amp. to 30-amp.	100	$0.15	3-amp. to 30-amp.	100	$0.30
35-amp. to 60-amp.	100	.30	35-amp. to 60-amp.	100	.60
61-amp. to 100-amp.	50	.90	65-amp. to 100-amp.	50	1.50
101-amp. to 200-amp.	25	2.00	110-amp. to 200-amp.	25	2.50
201-amp. to 400-amp.	25	3.60	225-amp. to 400-amp.	25	5.50
401-amp. to 600-amp.	10	5.50	450-amp. to 600-amp.	10	8.00

Discount: Less than one-fifth standard package, 60%; one-fifth to standard Package, 64%; standard package, 70%.

RENEWABLE FUSES—List price each:

Sizes	250-Volt List-Price	600-Volt List-Price	Std. Pkg. Quantity	Carton Quantity
1 to 30-amp.	$0.50	$1.10	100	10
35 to 60-amp.	1.00	1.25	100	10
65 to 100-amp.	2.00	3.00	50	5
110 to 200-amp.	4.00	5.00	25	5
225 to 400-amp.	7.50	11.00	25	1
450 to 600-amp.	11.00	16.00	10	1

REFILLS—

1 to 30-amp.	$0.03 ea.	$0.05	100	100
35 to 60-amp.	.05 ea.	.06	100	100
65 to 100-amp.	.10 ea.	.10	50	50
110 to 200-amp.	.15 ea.	.15	25	50
225 to 400-amp.	.30 ea.	.30	25	25
450 to 600-amp.	.60 ea.	.60	10	10

Discount Without Contract—Fuses:	
Broken cartons	Net
Unbroken cartons	22%
Ten unbroken cartons	40%
Discount Without Contract—Renewals:	
Broken cartons	Net list
Unbroken cartons	22%
Ten unbroken cartons	40%
Discount With Contract—Fuses:	
Broken cartons	10%
Unbroken cartons	26%
Ten unbroken cartons	42%
Discount With Contract—Renewals:	
Broken cartons	Net list
Ten unbroken cartons	42%

Carton quantities may be combined to obtain maximum discounts.

FUSE PLUGS, MICA CAP—

0-30 ampere, standard package (500)	$2.50
0-30 ampere, less than standard package	2.80

LAMPS—Below are present quotations in less than standard package quantities on Mazda standard, A type bulbs:

100—130 Volt General Watts	Type	Price Each	200—260 Volt Special Watts	Type	Price Each
15	A 17	$0.20	25	A 19	$0.25
25	A 19	.20	50	A 21	.25
40	A 21	.20	100	A 23	.45
50	A 21	.22	....	....	....
60	A 21	.22	....	....	....
100	A 23	.35	....	....	....

Standard pkg. quantities are subject to discount of 10% from list. Annual contracts ranging from $75 to $300,000 net, allow a discount of 15 to 40% from list.

PLUGS, ATTACHMENT—

	Each
Porcelain, separable, attachment plug	$0.18
Composition, 2-piece, attachment plug	.27
Swivel attachment plug	.12
Small size, 2-piece plug, composition	.07

RUBBER-COVERED COPPER WIRE—Per 1000 ft. f. o. b. New York:

No.	Solid Single Braid	Solid Double Braid	Stranded, Double Braid	Solid Duplex
14	$6.25	$8.50	$10.50	$18.30
12	9.50	11.10	13.10	23.60
10	12.90	14.70	16.80	31.25
8	18.85	20.60	22.40	44.00
6	.....	.....	33.00	.....
4	.....	.....	46.80	.....
2	.....	.....	65.50	.....
1	.....	.....	88.20	.....
0	.....	.....	105.00	.....
00	.....	.....	126.00	.....
000	.....	.....	152.00	.....
0000	.....	.....	184.50	.....

SOCKETS, BRASS SHELL—Price each, net:

	¼ In. or Pendant Cap Key	¼ In. or Pendant Cap Keyless	¼ In. or Pendant Cap Pull	⅜ In. Cap Key	⅜ In. Cap Keyless	⅜ In. Cap Pull
Standard package	$0.12	$0.10	$0.16	$0.16½	$0.14	$0.20
Unbroken carton	.14	.12	.18	.18	.16	.21
Broken carton	.16	.14	.20	.20	.18	.24

WIRING SUPPLIES—

Friction tape, ¾ in., less than 100 lb., 31c. per lb.	100 lb. lots	29c. per lb.
Rubber tape, ¾ in., less than 100 lb., 33c. per lb.	100 lb. lots	31c. per lb.
Wire solder, less than 100 lb., 33c. per lb.	100 lb. lots	31c. per lb.
Soldering paste, 2 oz. cans		$1.00 doz.

ENCLOSED SWITCHES, KNIFE—Safety type, externally operated, 250 d.c. or a.c., N.E.C.

TYPE "C" FUSED BOTTOM

Size, Amp.	Double Pole, Each	Three Pole, Each	Four Pole Each
30	$4.50	$6.00	$7.25
60	7.50	8.25	10.50
100	10.50	13.00	22.50
200	16.00	20.00	30.00

Discounts:	
Less than $25.00 list value	30%
$25.00 to $50.00 list value	35%
$50.00 list value or over	40%